Objective: To determine the incidence and type of delayed complications from nonoperative management of adult splenic injury.

Design: Retrospective medical record review.

Setting: University teaching hospital, level I trauma center.

Patients: Two hundred eighty patients were admitted to the adult trauma service with blunt splenic injury during a 4-year period. Men constituted 66% of the population. The mean (±SEM) age was 32.2±1.0 years and the mean (±SEM) Injury Severity Score was 22.8±0.9. Fifty-nine patients (21%) died of multiple injuries within 48 hours and were eliminated from the study. One hundred thirty-four patients (48%) were treated operatively within the first 48 hours after injury and 87 patients (31%) were managed nonoperatively.

Main Outcome Measures: We reviewed the number of units of blood transfused, intensive care unit length of stay, overall length of stay, outcome, and complications occurring more than 48 hours after injury directly attributable to the splenic injury.

Results: Patients managed nonoperatively had a significantly lower Injury Severity Score (P<.05) than patients treated operatively. Length of stay was significantly decreased in both the number of intensive care unit days as well as total length of stay (P<.05). The number of units of blood transfused was also significantly decreased in patients managed nonoperatively (P<.05). Seven patients (8%) managed nonoperatively developed delayed complications requiring intervention. Five patients had overt bleeding that occurred at 4 days (3 patients), 6 days (1 patient), and 8 days (1 patient) after injury. Three patients underwent splenectomy, 1 had a splenic artery pseudoaneurysm embolization, and 1 had 2 areas of bleeding embolization. Two patients developed splenic abscesses at approximately 1 month after injury; both were treated by splenectomy.

Conclusion: Significant numbers of delayed splenic complications do occur with nonoperative management of splenic injuries and are potentially life-threatening.

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AS SURGEONS have become more comfortable with nonoperative management of splenic injuries in both children and adults,1-4 the traditional indications for nonoperative management have liberalized. This trend is pushed further by today’s managed care environment, as physicians and administrators look for ways to cut costs without sacrificing quality of care. We wondered if relaxing the criteria for nonoperative management or changing the monitoring and follow-up was potentially harmful to patients. Therefore, the purpose of this study was to identify delayed (>48 hours) complications directly attributable to the nonoperative management of splenic injury in adults.

RESULTS

The clinical data for the 4 groups are presented in Table 1. Men constituted 66% of the population. Motor vehicle crash was the predominant mechanism of injury in 220 patients (79%), followed by motor vehicle/pedestrian collision in 17 (6%), motorcycle crash in 11 (4%), falls in 9 (3%), bicycle crash in 4 (1%), assaults in 4 (1%), all-terrain vehicle crash in 3 (1%), sports-related in 3 (1%), and other in 9 (3%). There were no significant differences between the 4 groups in the mechanism of injury. There was no significant difference in age between those patients treated operatively and those managed nonoperatively. However, the patients who died within 48 hours of injury were signifi-
PATIENTS AND METHODS

A total of 10,472 patients with blunt trauma were admitted to Hermann Hospital, Houston, Tex, during a 4-year period (January 1, 1993, through December 31, 1996). Three hundred twenty-one patients were identified through our trauma registry as having sustained blunt trauma to the spleen. To examine delayed complications of splenic injuries in adults managed nonoperatively, we included only patients 14 years and older admitted to our adult trauma service. This left 280 patients for review. These patients were separated into 4 groups. Group 1 includes all 280 adult patients with splenic injury; group 2, all 59 patients who died of their multiple injuries within 48 hours of admission; group 3, all 134 patients who required splenectomy or splenorrhaphy within the first 48 hours of injury; and group 4, all 87 patients who had splenic injuries managed nonoperatively.

Delayed complications were defined as any complication directly attributable to the splenic injury that occurred more than 48 hours after injury. Delayed complications were identified by reviewing the proceedings of the trauma morbidity and mortality conference. Cases identified as having potential splenic complications underwent a focused medical record review as well as being discussed with the responsible attending physician. Seven patients were found to have delayed complications attributable to their splenic injuries that required intervention.

The following data was obtained from our trauma registry: age, sex, race, mechanism of injury, Injury Severity Score (ISS), number of intensive care unit (ICU) days, overall length of stay, number of units of blood transfused, day of operation, and discharge disposition. This project was undertaken with the permission of the Committee for the Protection of Human Subjects at the University of Texas–Houston Medical School.

Hermann Hospital is the main teaching hospital for the University of Texas–Houston Medical School and a level I trauma center with an active air ambulance service serving the greater Houston area. The trauma service at Hermann Hospital during the time of this study evaluated all injured patients aged 14 years and older. The standard approach to the patient with suspected abdominal injury was as follows. All unstable patients underwent diagnostic peritoneal lavage, while those who were hemodynamically stable underwent abdominal computed tomographic (CT) scanning. When the number of patients requiring CT was so great as to cause an untimely delay, diagnostic peritoneal lavage was used instead. While most patients with a positive diagnostic peritoneal lavage underwent exploratory celiotomy, there were occasional stable patients with a positive diagnostic peritoneal lavage who underwent abdominal CT followed by observation. Stable patients with splenic injury were admitted for monitoring of their vital signs and hemoglobin level and an abdominal examination. Diet and activity were advanced as their conditions permitted. Routine follow-up CT scans were not obtained, unless the patient exhibited worsening of clinical symptoms or had a drop in hemoglobin levels that could not be explained by other injuries. During the time of this study, there were no specific guidelines for management of blunt splenic injury. These decisions were at the discretion of the attending surgeon.

Data are expressed as mean±SEM. Statistical comparisons of means were made using the Student t test. Level of confidence was defined as P<.05.

### Table 1. Clinical Data*

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>Age, y</th>
<th>ISS</th>
<th>Units of Blood Transfused</th>
<th>ICU Length of Stay, d</th>
<th>Total Length of Stay, d</th>
<th>Mortality, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (n = 280)</td>
<td>32.2±1.0 (14-91)</td>
<td>22.8±0.9 (4-75)</td>
<td>4.2±0.5 (0-49)</td>
<td>3.7±0.4 (0-43)</td>
<td>11.6±0.9 (0-141)</td>
<td>73 (26)</td>
</tr>
<tr>
<td>Group 2 (n = 59)</td>
<td>38.3±2.2† (15-75)</td>
<td>36.3±2.1 (10-75)</td>
<td>7.2±1.4 (0-49)</td>
<td>NA</td>
<td>NA</td>
<td>59 (100)</td>
</tr>
<tr>
<td>Group 3 (n = 134)</td>
<td>30.8±1.2 (14-81)</td>
<td>21.8±1.1 (4-75)</td>
<td>5.2±0.6 (0-47)</td>
<td>5.3±0.7 (0-43)</td>
<td>17.7±1.6 (3-141)</td>
<td>11 (8)</td>
</tr>
<tr>
<td>Group 4 (n = 87)</td>
<td>30.6±1.9 (14-91)</td>
<td>15.1±4.8† (4-41)</td>
<td>1.3±0.4 (0-27)</td>
<td>3.5±0.7‡ (0-31)</td>
<td>9.9±1.1 (0-67)</td>
<td>3 (4)</td>
</tr>
</tbody>
</table>

*See “Patients and Methods” section for explanation of patient groups. ISS indicates Injury Severity Score; ICU, intensive care unit; and NA, not applicable. All data are expressed as mean±SEM (range) unless otherwise indicated.

†P<.05 when the mean age of those who died is compared with those treated operatively or managed nonoperatively.

‡P<.05 when the ISS, the number of units of blood transfused, and the total length of stay are compared between operatively treated and nonoperatively managed patients.
patient) after injury. Three patients underwent splenectomy and 2 patients underwent angiography with embolization. Two patients developed splenic abscesses at approximately 1 month after injury and both were treated with splenectomy.

Table 2 briefly characterizes the 7 patients who developed complications. The first 5 patients all had delayed hemorrhage from their spleen, ranging from 4 to 8 days. Three of the 4 had significant other injuries. Four of the 5 patients had a slow downward drift of their hemoglobin levels, necessitating surgical exploration. One patient had an acute drop in hemoglobin level 4 days after injury. The older patients, ranging in age from 32 to 50 years, underwent splenectomy, while the younger patients (aged 17 and 18 years) were treated with embolization. One patient was actually sent home from the emergency department (patient 2) and returned 2 days later with left shoulder and abdominal pain. After being observed for an additional 2 days, he underwent surgical exploration for a downward drift of his hemoglobin level.

Patient 5 is an 18-year-old man who was injured in a motor vehicle crash. He suffered a left rib fracture and a left hemothorax. His initial abdominal CT scan found a splenic injury and a right perinephric hematoma. On day 6 after injury, a second abdominal CT scan was obtained because of a slow decrease in hematocrit. This showed a questionable vascular blush in the spleen. On day 8 after injury, he underwent successful embolization of a splenic artery pseudoaneurysm, shown in Figure 1.

Patient 6 is a 19-year-old man who fell from a roof. He was found to have a small splenic contusion on abdominal CT scan as well as a left shoulder dislocation. He remained hemodynamically stable throughout his hospital course but demonstrated an unwillingness to participate in aggressive pulmonary care, which culminated in the evolution of a left-sided Staphylococcus aureus pneumonia. This was treated with intravenous antibiotics, and he was subsequently discharged home. At 1 month after injury, he returned to the clinic complaining of shortness of breath, fever, and leukocytosis. Results of a chest x-ray film (Figure 2, top) showed what appeared to be a large pleural effusion. A chest tube was placed with incomplete resolution of the pleural effusion. An abdominal CT scan (Figure 2, bottom) showed a small pleural effusion and a large splenic abscess. He underwent splenectomy (which was difficult to perform given the size and local inflammation of the spleen) and recovered uneventfully.

Patient 7 is a 26-year-old man who fell and was found on evaluation of his abdominal pain by abdominal CT scan (Figure 3, top) to have an old splenic pseudocyst that had ruptured and caused free fluid in the abdomen. Although the patient denied any known splenic trauma,

<table>
<thead>
<tr>
<th>Patient No./Age, y/Sex</th>
<th>ISS</th>
<th>Mechanism</th>
<th>Associated Injuries</th>
<th>Initial Diagnostic Technique</th>
<th>Day</th>
<th>Complication</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/32/M 29/M</td>
<td>29</td>
<td>Motor vehicle crash</td>
<td>Closed head injury, smoke inhalation, left rib fractures, hemopneumothorax, lower-extremity burns</td>
<td>Negative DPL, CT</td>
<td>5</td>
<td>Hemorrhage</td>
<td>Splenectomy</td>
</tr>
<tr>
<td>2/50/M 10/M 3/46/M 22/M</td>
<td>10</td>
<td>Motor vehicle crash</td>
<td>Multiple abrasions, Frontal sinus fracture, pneumonecephalus, T5 and T8 vertebral body fracture, no neurological deficit, right 4th finger fracture</td>
<td>CT</td>
<td>4</td>
<td>Hemorrhage</td>
<td>Splenectomy</td>
</tr>
<tr>
<td>4/17/M 4/M</td>
<td>4</td>
<td>Sports injury</td>
<td>No other injuries</td>
<td>Positive DPL, CT</td>
<td>6</td>
<td>Hemorrhage</td>
<td>Embolization</td>
</tr>
<tr>
<td>5/18/M 18/M</td>
<td>18</td>
<td>Motor vehicle crash</td>
<td>Left rib fracture, left hemothorax, right perinephric hematoma</td>
<td>CT</td>
<td>8</td>
<td>Pseudoaneurysm</td>
<td>Embolization</td>
</tr>
<tr>
<td>6/19/M 9/M</td>
<td>9</td>
<td>Fall</td>
<td>Left shoulder dislocation, pleural effusion</td>
<td>CT</td>
<td>&gt;30</td>
<td>Splenic abscess</td>
<td>Splenectomy</td>
</tr>
<tr>
<td>7/26/M 4/M</td>
<td>4</td>
<td>Fall</td>
<td>No other injuries</td>
<td>CT</td>
<td>&gt;30</td>
<td>Splenic abscess</td>
<td>Splenectomy</td>
</tr>
</tbody>
</table>

*ISS indicates Injury Severity Score; DPL, diagnostic peritoneal lavage; and CT, computed tomography.
he was a bull rider; thus, the calcified cyst was presumed to be a traumatic splenic pseudocyst. He was discharged from the hospital 2 days after the fall when he had remained stable and his hemoglobin level did not drop. He returned 2 weeks later with obvious ascites and a reaccumulation of the cystic fluid (Figure 3, bottom). It was percutaneously drained and he was sent home with the drain in place. He returned 2 weeks later (having missed his follow-up appointment) with fever, leukocytosis, and a splenic abscess. He underwent splenectomy and recovered uneventfully.

The criteria for nonoperative management of splenic injuries in adults have traditionally included (1) no hemodynamic instability after minimal fluid resuscitation; (2) documentation of splenic injury by imaging techniques; (3) absence of a serious associated intra-abdominal injury; (4) no altered level of consciousness that may interfere with serial abdominal examinations; and (5) age younger than 55 years. At our institution, there are no specific guidelines for management of blunt splenic injuries. The only definite requirement for nonoperative management is that the patient be hemodynamically stable. Age is not considered a contraindication, nor is the presence of a head injury. Transfusion remains a variable that changes from patient to patient but, because of the strong involvement of the pediatric surgeons in our trauma group, we have become more liberal with the use of transfusion in attempting nonoperative management of splenic injuries. Risk of transfusion and nonoperative management of splenic injury have remained controversial, despite the decreased risk of transfusion-related infections.

In the past, patients selected for nonoperative management were routinely prescribed several days of bed rest, given nothing by mouth, and had nasogastric decompression. The patient’s hemoglobin level and abdominal examination results were checked frequently during the first 24 hours and then less frequently as the patient’s condition dictated. Follow-up CT scans have been advocated to document resolution of the injury. The overall duration of hospitalization for isolated splenic injury was 5 to 10 days, depending on the patient and the degree of injury.
This scenario is being challenged in today’s managed care environment as physicians and administrators look for ways to cut costs without sacrificing quality of care.14 We rarely use nasogastric decompression for the isolated splenic injury. Patients are fed and mobilized much quicker than in the past because we are being asked to discharge patients from the hospital sooner. Follow-up studies are obtained only when indicated by the clinical examination results.15 Any request for follow-up studies as an outpatient must be approved by the primary care provider; the uninsured patient must pay “up front” for the test. In addition, many patients are being told by their insurance plans that they must follow up with their primary care physician.

Because of this liberalization of the criteria for nonoperative management of splenic injury and the push to decrease hospital and outpatient costs, we decided to focus on patients who developed delayed complications from their nonoperatively managed splenic injuries. Our study found an 8% incidence of delayed complications of nonoperative management of adult splenic injuries. This is difficult to compare with others, as most authors report all patients who fail nonoperative management, which includes those who require operative intervention within 48 hours.1,13 Complications other than hemorrhage are often presented as isolated case reports.16-19 In our series, the delayed complications (>48 hours) include delayed hemorrhage, splenic artery pseudoaneurysm, splenic pseudocyst, and splenic abscesses.

Although most patients who fail nonoperative management will require splenectomy or splenorrhaphy within 48 to 72 hours,20 we had 5 patients (6%) who bled from their splenic injuries 4 or more days following injury. This is similar to the Western Trauma Association’s 5-year, multi-institutional study in which 5 (5%) of 112 patients managed nonoperatively bled more than 4 days after injury.1 Rupture of a subcapsular hematoma has been implicated as the cause of most delayed splenic bleeding; however, Black et al21 concluded that a subcapsular hematoma is neither a predictor for delayed splenic rupture nor an indication for operative treatment. The cause in such cases is most probably secondary bleeding from the lysis of clotted blood at the site of the original injury.22

Splenic artery pseudoaneurysms are reported following trauma and are another potential mechanism for delayed splenic hemorrhage.12,16,18 The natural history of this entity is unknown. When identified, it should be treated with embolization and splenectomy should be considered only when embolization or splenorrhaphy are not technically feasible.

Similar to previous reports,13,23 our study had 1 patient who had delayed hemorrhage requiring splenectomy and was noted to have normal results on abdominal CT scan on hospital admission. Although Buntain et al24 found that their classification correlated with a need for operative treatment, others have found that higher grades of splenic injury on CT do not necessarily correlate with an increased rate of failure of nonoperative management.25,26

Splenectomy is the usual treatment of choice; however, selected patients may be considered for percutaneous drainage.31,32 A study such as this should prompt physicians to review their management algorithms. We, like most trauma centers, have begun to employ ultrasonography as our initial screening tool for abdominal injury. Ultrasonography is a rapid, sensitive test for determining the presence of free intra-abdominal fluid,33 yet it is not as sensitive as CT in determining the source of the fluid.34-36 Our current algorithm for the evaluation of blunt abdominal trauma preferentially uses abdominal ultrasonography in both stable and unstable patients as the initial screening tool. Stable patients undergo CT scanning if ultrasonography results are abnormal or if the patient has an indication for another type of CT. By increasing the use of ultrasonography and decreasing the use of abdominal CT, we decrease costs but increase the possibility of missed splenic injuries.

This study did not attempt to define the management of patients with blunt splenic injury, but looked at the late complications that develop following injury. These are the complications that can occur when patients are sent home early with either a known splenic injury or even an unknown splenic injury. Delayed complications from nonoperative management of adult splenic injuries do occur. The complication rate is significant and indiscriminate discharge of patients with blunt splenic injury may be potentially harmful. As we strive to decrease hospital costs and decrease length of stay while maintaining high-quality medical care, this study should prompt us to remember that patients with splenic injury have the potential for developing life-threatening complications. Patients must be instructed carefully as to what to watch for and physicians must maintain careful follow-up of patients with abdominal trauma.

Presented at the 105th Scientific Session of the Western Surgical Association, Colorado Springs, Colo, November 18, 1997.
REFERENCES


DISCUSSION

Robert J. Baker, MD, Chicago, Ill: This manuscript is concise, to the point, and it adds significantly to the body of information about nonoperative management of splenic trauma in adults. It is important that the age of the patient was not a contraindication to nonoperative management. The literature is replete with contributions, largely before 1990 but also in more recent papers, proposing that patients older than 55 years should not be managed nonoperatively. There are patients in this group, and the oldest I saw in the manuscript was 91 years of age, who were managed without operation. The current trend is to do just that. I would ask how many of the patients in this cohort of 87 were actually older than 55 years. Did you notice any particular difference in blood transfusion requirements or in other parameters that influenced outcome in these older patients?

The second issue relates to CT scanning in splenic trauma. A number of authors have adopted the Buntain classification of splenic trauma, grading it 1 to 6, proposing that this is a viable way to differentiate patients who should be operated on from those best treated nonoperatively. I wonder whether this CT evaluation of splenic rupture was used by the authors to decide whether operative or nonoperative measures should be used? Obviously, the principle that a grade 4 lesion should not be treated nonoperatively is difficult to justify with our current understanding that CT scans often overestimate splenic as well as hepatic damage.

There was one arteriogram shown in the series, in the patient who had a branch pseudoaneurysm of the splenic artery; is arteriography still advocated following a positive CT scan? In Chicago, most of the CT scanning now is done with intravenous bolus contrast and the helical CT scanner. Whether the arteriogram adds anything is hard to say, but I would like to hear the authors’ comments.

There are 2 major concerns with nonoperative treatment, the first of which is that no other injuries be missed; there were no missed injuries in this series. The other is that with nonoperative therapy, splenic salvage is often compromised after a delay and it may then not be possible to repair the spleen when operation becomes necessary. None of the 7 patients who were operated on for late complications did have splenic salvage, but the question is whether any of the 6 patients who were operated on after observation but in the first 48 hours of proposed nonoperative management had splenorrhaphy. Overall, in your experience, does delay significantly impact on your ability to save the spleen?

Ernest E. Moore, MD, Denver, Colo: This report is timely and critical to emphasize the difference between the behavior...
of major liver fractures vs splenic injuries. We tend to follow
the literature on liver injuries and assume that spleens will be-
have similarly. It is noteworthy that these delayed bleeds oc-
curred at 4 to 5 days. Did your helical CT scans show you any-
thing that might identify a high-risk patient who may be a
candidate for presumptive arterial embolization? Alterna-
tively, a more aggressive surveillance of these high-risk pa-
tients could be done with ultrasound. While follow-up CT scan-
ning in liver injury has been discouraged, ultrasound may serve
an important role for the spleen injuries.

Dr Moore: Dr Baker has asked several cogent ques-
tions. The first issue was how many of our patients managed
nonoperatively were older than 55 years. At our institution,
advanced age is not a contraindication for low-grade splenic
injuries. An important factor in our decision tree is whether
comorbid disease exists. Elderly patients appear to have a
higher failure rate. If they have comorbid disease, failure
may lead to an adverse outcome. For example, if a patient
has coronary artery disease, they will go to the operating
room, not the ICU, to be observed. As far as the use of the
CT scan results to decide whether early operations
would be performed, I believe that we follow the national
trend. Grade 1, 2, and 3 splenic injuries would be managed
nonoperatively unless the patient is hemodynamically
unstable or has evidence of a hollow viscus injury. Of note,
one of our patients had a vascular blush on the initial
CT scan. This is indicative of ongoing bleeding and thus
makes this a grade 4 injury. With the advent of the helical
CT scanner, we see more vascular blushes. This is of con-
cern and might be an indication for presumptive angio-
graphic embolization.

Dr Baker also commented on the issue of missed hollow
viscus injuries. In a recent review of our experience at Her-
mann Hospital, 0.8% of adults will have a hollow viscus in-
jury. An associated splenic injury increases the risk of hollow
viscus injury by 6-fold. These hollow viscus injuries, how-
ever, are rarely occult. Extravasation of dye is rare. Addition-
ally, while pneumoperitoneum has been emphasized to be an-
other important sign, in our experience it is nonspecific. What
we look for is changes in bowel morphology, including dil-
tion of the bowel, thickened bowel wall, or streaking of the mes-
entry. Often we are not happy with the initial contrast CT scans.
The contrast has not had time to move out of the stomach. If
we are concerned, the CT scan will be repeated. Alternatively,
if we are concerned about a duodenal injury, we get a C-loop
contrast study.

Concerning the issue about splenectomy vs splenorha-
phry for failure of nonoperative management, our surgeons
are inclined to do a splenectomy. I believe this is inappropri-
ate. There is ample evidence in the literature that the rates of
salvage following failure of nonoperative management are
the same as for patients undergoing early operative manage-
ment. In regards to ultrasound, we have no experience, but
it is a good idea.