Is anything new in adult blunt splenic trauma?

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Abstract

Several decades ago, a shift occurred in the management of adult splenic injuries. Influenced by the experience in pediatric trauma patients, adult trauma surgeons began turning from mandatory operative treatment of all splenic injuries toward nonoperative management. Nonoperative treatment is now the most common method of management for patients with splenic injuries and is the most common method of splenic salvage. However, controversy exists about how to appropriately select patients for nonoperative treatment since bleeding from splenic injuries can incur significant morbidity and mortality. Recent refinements in the management of adult blunt splenic injuries will be reviewed. © 2005 Excerpta Medica Inc. All rights reserved.

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In ancient times, the spleen was thought to regulate the balance of bodily humors, process different forms of “bile,” aid in digestion, influence emotions, and regulate the soul [1,2]. Splenectomy for injury was recorded as early the 16th century and for centuries, the spleen was generally considered to be expendable [3,4]. Several decades ago, the association of splenectomy with a rapidly progressive and fulminating systemic infection due to encapsulated organisms became more widely known. Beginning with pioneering work in pediatric surgery, nonoperative management of abdominal solid organ injuries began to be applied. The initial skepticism regarding the appropriateness of nonoperative management for blunt abdominal solid organ injuries in adults has now been replaced by the acceptance of nonoperative management for the majority of patients. The Department of Surgery at the University of Louisville has a well-established tradition of leadership in providing clinical trauma care to injured patients, in performing clinical research, and in advancing basic science research to provide the best possible care for future patients. This tradition flourished under Hiram C. Polk, Jr, M.D., and included a number of contributions to our understanding of splenic trauma and its management [5–8]. Today, the primary question for patients with splenic injuries is not whether nonoperative management can be utilized but more specifically which patients are good candidates and which patients should be treated operatively. Additional topics that are debated today include whether ultrasound should be used alone or in combination with computed tomography (CT), whether follow-up imaging of splenic injuries is necessary, and clarification of the role of angiography in the armamentarium of trauma surgeons for managing splenic trauma. However, it is difficult to appreciate the current status of the management of splenic injuries without understanding some of the important events through time that have influenced the care of the injured patient.

Historical Perspective

Writings on the anatomy and function of the spleen can be found in the work of Hippocrates, Aristotle, and Galen [1–3]. Most splenic injuries at that time would have been from penetrating wounds related to combat and given the limitations in medical care of the injured patient, survival would have depended little on the management of specific injuries since few intra-abdominal injuries were directly treated. The first operation on the spleen performed for trauma was recorded in the 16th century and the initial operations were performed on spleens that herniated through large flank wounds [1–3]. The survival of these patients and the negligible effects on the health of dogs that had undergone splenectomy supported the argument that the
The spleen could be removed with relative impunity [1–3]. The recognition of blunt splenic injuries was limited by the diagnostic tools of the time, which consisted principally of physical examination. The clinical manifestations of shock were recognized but not attributed to hypovolemia and blood loss until the early 20th century [9]. Therefore, splenic injuries not associated with shock or peritonitis would have gone undetected. Following improvements in general anesthesia that led to a rapid expansion of surgical techniques for a wide variety of diseases, operations on the spleen were undertaken for medical conditions as well as trauma. Splenic injuries severe enough to cause shock or peritonitis would typically be significant, destructive injuries and so it is not surprising that the standard treatment for injuries coming to laparotomy was splenectomy. The occurrence of “delayed splenic hemorrhage” was described as a potential complication of splenic trauma and supported the recommendation for splenectomy as routine treatment of all splenic injuries. In reality, though, many cases of “delayed splenic rupture” probably represented “delayed recognition” due to unrecognized bleeding, late manifestations of shock and the limited diagnostic tools of the day. Nevertheless, physical examination for diagnosis and splenectomy for treatment were the mainstays of therapy for decades and it is not known how many minor injuries may have been present without shock or peritonitis and never been identified.

The development of diagnostic peritoneal lavage DPL by Root et al in the 1965 was a tremendous advance for trauma surgeons and trauma patients [10]. It allowed surgeons to quickly diagnose hemoperitoneum and aided rapid decision making for trauma patients. Unfortunately, this technique provided no information about which organs were injured. Diagnostic peritoneal lavage identified patients with active intraperitoneal bleeding but also uncovered large numbers of patients who had minor injuries that had either stopped bleeding or were able to be controlled with relatively minor means. This limitation led to a high frequency of nontherapeutic laparotomies in which minor liver and spleen injuries were identified but no active intervention performed [11]. In the 1950s, case reports and small studies began appearing describing a fulminant, rapidly progressive and frequently lethal systemic infection in patients who had undergone a splenectomy [12]. It was not until the report of Singer that factors important in the pathogenesis of this syndrome were described and many of the characteristics of the process currently called overwhelming post-splenectomy infection (OSPI) were identified [13]. Once a contribution of the spleen to the development of OSPI was recognized, operative splenorrhaphy became accepted and developed into the most common method for splenic salvage [1–3].

Improvements in CT led to the ability to image and evaluate internal organs and CT soon began to be applied to injured patients [14]. CT could detect hemoperitoneum, could identify which organ caused the hemoperitoneum, and could provide a qualitative estimate of organ injury severity. Over time, case reports began to appear, primarily in the pediatric surgical literature, on the nonoperative management of intra-abdominal solid organ injuries [3]. These techniques were slowly introduced into the adult population as trauma surgeon experience and CT technology improved. Gradually, widespread adoption of nonoperative management for many splenic injuries became commonplace. Older generation CT scanners provided information about the location and magnitude of abdominal injuries but were limited by the time required to capture information and format images. Newer scanners with helical technology now rapidly gather and format images so that the time required to obtain useful images is much less. Institution-specific issues may still exist such as the number and accessibility of scanners for injured patients, the distance patients must be transported to undergo CT, and the availability of experienced people to interpret the images. CT, however, has become the gold standard for the diagnosis of splenic injuries after trauma [15]. More recently, the use of ultrasound to identify hemoperitoneum has been adopted in many trauma centers, extrapolated from the experience of European trauma surgeons, and has allowed trauma surgeons to identify hemoperitoneum with a high degree of accuracy in a noninvasive manner at the bedside [16,17]. As with DPL, however, ultrasound identifies the presence of hemoperitoneum but does not identify the source of blood nor the magnitude of injury that produced the hemoperitoneum. It has, however, become used commonly in the evaluation of injured patients in US trauma centers.

Over the last few decades, further refinement of the indications for nonoperative treatment, the inclusion of more severe splenic injuries for nonoperative treatment, and the exploration of minimally invasive techniques for the care of the injured patient have been explored. Currently, nonoperative management has replaced splenorrhaphy as the most common method of splenic salvage [3]. Furthermore, the shift towards nonoperative therapy for the majority of splenic injuries has meant that operations are reserved for the most severely injured patients and therefore splenectomy is performed far more frequently than splenorrhaphy [18]. Data from a state trauma registry demonstrate that splenorrhaphy is performed approximately 6% of the time when operations on the spleen are undertaken while the proportion of splenectomies is increasing (Harbrecht BG, unpublished data).

**Risks and Benefits of Nonoperative Management**

The identification of OSPI as a potential complication after splenectomy helped accelerate the shift toward nonoperative management of blunt splenic injuries. Unfortunately, there are insufficient data to define precisely what the risk for OSPI is in the injured adult who undergoes splenectomy. The initial rates of OSPI derived from children with hematologic diseases, with the confounding immature immune
system and possible immune dysfunction from their underlying hematologic problems, appears to be excessive when compared to healthy adults undergoing splenectomy for trauma [3,12,13]. Several recent reviews have attempted to determine the incidence of OPSI but obtaining reliable data is difficult [19,20]. Current estimates of the risk of OPSI suggest that in adult trauma victims, it is a real but infrequent occurrence [19,20]. However, the potential for OPSI as well as the complication rate for nontherapeutic laparotomies emphasizes the need to avoid operations on patients who will not benefit [11].

Several studies have shown that factors previously thought to preclude nonoperative treatment such as age can be associated with successful nonoperative management, although deciding which patients can be safely treated nonoperatively can be complex [21–23]. What the appropriate failure rate of nonoperative treatment should be is difficult to estimate and may depend, in part, on institutional resources [24]. However, it is also clear that there are risks associated with failure of nonoperative management. Failure of nonoperative management of blunt splenic injuries is associated with a significant increase in hospital length of stay and, in selected subsets of patients, with increased mortality [18,23,25]. The need for blood transfusions or development of hypotension are frequently used to identify patients who are failing nonoperative management [22]. Hypotension significantly increases morbidity and mortality in addition to being a risk factor for the development of multiple organ dysfunction syndrome [26]. These factors emphasize the need to accurately define which patients can be safely managed nonoperatively. Simply put, patients who are bleeding from their splenic injuries need to have their hemorrhage controlled. Unfortunately, determining which patient is bleeding from their splenic injury is a crude science at best. A number of factors have been examined to determine the clinical predictors of failure of nonoperative management and which factors identify patients who can be managed nonoperatively with a high degree of safety. While hemodynamic status has uniformly been considered a contradiction to managing splenic injuries nonoperatively, no consensus definition for “hemodynamic instability” exists. Magnitude of splenic injury and quantity of hemoperitoneum have not been consistently associated with predicting who will fail nonoperative treatment [3,22,27,28]. A list of characteristics cannot be constructed that uniformly assures success for nonoperative treatment in all cases. Thus, considerable surgical judgment must be applied in each individual case.

New Debates

Over the last decade, a few new wrinkles have been added to the evaluation and treatment of patients with splenic injuries. These include refinements in the utilization of ultrasound in the evaluation and diagnosis of injured patients with suspected intra-abdominal injury, the significance of abnormal patterns of vascular contrast enhancement seen on CT, the utility of angiography in the management of patients with splenic injuries, and the need for follow-up imaging of splenic injuries.

Should CT be performed after a negative FAST?

The focused abdominal sonogram for trauma (FAST) is widely used in the evaluation of the injured patient. FAST has a sensitivity of 90% to 93% for detecting hemoperitoneum and sensitivity and specificity improve with experience [16,17]. It has been demonstrated, however, that ultrasound is relatively insensitive for detecting small amounts of intra-abdominal fluid and several hundred milliliters may be required before being detectable by the average examiner [29]. For patients who are hemodynamically “stable,” a FAST detecting hemoperitoneum often leads to CT to further delineate the anatomic injuries producing the hemoperitoneum and to aid decision-making regarding operative or nonoperative management [3]. When the FAST is negative for hemoperitoneum, debate exists regarding whether further diagnostic imaging is required. This controversy basically boils down to the ability to define how often significant intra-abdominal injuries are present in the absence of hemoperitoneum or associated with a quantity of hemoperitoneum undetectable by FAST. Estimates for the presence of intra-abdominal injuries in the absence of hemoperitoneum on FAST can be as high as 29% [17,30]. Some of these injuries represent relatively minor liver and spleen injuries that may have good outcome whether they are identified or not. How many of these injuries are severe, have the potential for late hemorrhage, or are associated with other intra-abdominal injuries that might require surgical treatment (such as small intestinal injuries) has not yet been rigorously defined.

Importance of abnormal vascular enhancement

The presence of a contrast “blush” or contrast “extravasation” has generated a moderate amount of interest when evaluated in the context of splenic injuries. The term “contrast blush” was used to describe well-circumscribed densities within the splenic parenchyma [31]. Further delineation of these areas with angiography demonstrated that many of these represented splenic vascular abnormalities or pseudoaneurysms and many of these lesions were amenable to angiographic control [32]. Reports of abnormal vascular patterns on CT called “contrast extravasation” correlated highly with the need for operative management or angiographic embolization of the splenic injury [33]. Recent reports have questioned the significance of abnormal contrast patterns and suggested that a contrast blush or extravasation may not mandate intervention either surgically or angiographically [34].

How is the clinician supposed to interpret this apparently
conflicting information? Part of the answer may lie in the fact that these reports may be describing separate entities that are associated with different anatomic abnormalities. A contrast blush, as defined above, often corresponds to pseudoaneurysms of the splenic artery or its branches [31,32] (Fig. 1). It has been suggested that these lesions may be at risk for delayed bleeding and subsequent failure of nonoperative treatment. It has also been suggested that these abnormalities may not be apparent on initial CT but may be detectable on delayed CT imaging (48–72 hours) [32]. The natural history of these lesions is not clearly known. While some of these lesions may resolve on their own, thrombose, represent tortuous but uninjured vessels, or have a benign clinical course as suggested by Omert et al [34], predicting which lesions will be significant and which will be inconsequential is imprecise at best. On the other hand, “contrast extravasation” can represent any abnormality, including irregularly shaped collections of intravenous contrast material outside of the splenic parenchyma itself [33]. The shape of these collections corresponds to the varied and irregular shape expected from leakage of contrast outside of the vascular system (Fig. 1). Intuitively, one would anticipate that any lesion that bleeds briskly enough to permit visualization of intravascular contrast outside the parenchymal organ would be bleeding rapidly and would require prompt hemorrhage control.

Role of angiography

As discussed in the previous section, angiography has been applied more frequently in the evaluation of patients with splenic injuries. Some centers employ angiography liberally for the evaluation of active bleeding, the search for extravasating vascular injuries, and subsequent angiographic control [35]. The other commonly used application for angiography in patients with splenic injuries is in hemodynamically stable patients who are thought to be at high risk for delayed bleeding, as an adjunct to nonoperative treatment, looking for vascular abnormalities such as pseudoaneurysms that pose a risk for subsequent rupture and delayed hemorrhage [32]. Angiography in this manner might be used acutely for patients with high-grade splenic injuries directly upon presentation to the Emergency Department. It might also be applied when contrast blush is identified on CT imaging [32].

Wide application of angiography in the evaluation and treatment of injured patients is not without risk. The risk of transporting patients who might develop shock and life-threatening hemorrhage to radiology for a time-consuming intervention is significant. Few centers have angiographic resources immediately available or radiologists skilled at rapid enough angiography to make this alternative widely acceptable. The effectiveness of angiography in treating actively bleeding splenic injuries, the frequency of the need for secondary procedures (laparotomy or repeat angiography), the complication rate (ongoing bleeding, vascular injury, distal embolization, thrombosis of access sites), and the long-term sequelae are all incompletely known. Whether angiographic embolization decreases splenic function in trauma patients is unknown. The amount of viable splenic tissue required to maintain immunocompetence has been studied in animal models but not in human subjects [3]. Angiographic embolization is performed either at the level of the main splenic artery to decrease total splenic arterial inflow or at the segmental level for the directed treatment of isolated vascular abnormalities [32,35]. The latter technique requires greater time and angiographic manipulation but preserves native flow to a substantial portion of the spleen. The former technique is faster but eliminates all inflow to the spleen except collateral flow through the short gastrics. Collateral flow might develop over time through the pancreatic–duodenal arcade, although the frequency of this occurrence in trauma patients is unknown.

The long-term effect on splenic immune function of the occlusion of the main splenic artery in trauma patients is also unknown. Occlusion of the splenic artery was used to
control hypersplenism associated with cirrhosis and portal hypertension. Unfortunately, collateral flow developed and the manifestations of hypersplenism returned [36], suggesting that over time sufficient collateral flow may develop to preserve splenic function in trauma patients. Studies of splenic function after operative splenic artery ligation are consistent with the potential for preserved splenic immune function [37,38]. However, the effects of splenic artery embolization on splenic function in large series of trauma patients have not been studied.

Role of follow-up imaging in splenic trauma

The initial management decisions are often based on hemodynamic status and initial diagnostic imaging. Once the treatment modality is chosen, whether routine follow-up imaging is helpful in stable patients who have no change in their clinical condition has been debated. Two areas for follow-up imaging have been explored. One is in the subacute setting, early in the treatment course to re-evaluate major splenic injuries for the development of pseudoaneurysms that might predispose patients to failure of nonoperative treatment as discussed above [32].

The other common area discussed regarding routine follow-up imaging of blunt splenic injuries revolves around determining return to activity after injury. Whether routine follow-up imaging helps manage the stable patient who is responding appropriately to nonoperative management without clinical suspicion for bleeding from their splenic injury is debatable [3]. Some have suggested that routine follow-up imaging for most blunt splenic injuries adds little to clinical decision making in the stable patient except higher overall costs [3]. Since most blunt splenic injuries are low grade injuries, these authors may be correct. Whether follow-up imaging is valuable for a subset of patients, such as those with higher grade injuries, is difficult to either confirm or refute. The role of follow-up imaging to document healing prior to a return to unrestricted activity or physical labor has not been thoroughly studied but is practiced in some settings [3].

Conclusions

Splenic injuries continue to represent common intraabdominal injuries after blunt trauma. They appear to be more frequently diagnosed as CT imaging is increasingly used for the evaluation of injured patients. The majority of diagnosed splenic injuries these days are minor, low-grade injuries that are amenable to nonoperative management. Angiography has been added to the diagnostic and treatment options for patients with splenic injuries for selected cases. Its role continues to undergo refinement and its effect on splenic immunologic function has not been defined. The effects of angiographic embolization of the spleen on ultimate splenic immune function may depend on the technique used, the caliber of the vessel embolized, and the development of collateral flow over time. The ultimate role and utility of follow-up imaging on a routine basis will require further study but, given the preponderance of low-grade injuries, routine repeat imaging may add little to the management of blunt splenic trauma except in selected groups of patients.

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