MANAGEMENT OF BLUNT SPLENIC INJURY

SUMMARY

Splenic injury can be initially managed with observation, angiographic embolization, or surgery depending upon the hemodynamic status of the patient, grade of splenic injury, and presence of other injuries and medical comorbidities. Evolving practice beginning in the pediatric population and expanding into adults, has allowed non-operative observation to become more prevalent for hemodynamically stable patients. Improvements in CT sensitivity and specificity have made vascular extravasation easier to diagnose, and interventional radiology has become an integral part of the management of splenic injuries, in some institutions replacing emergency operation as the treatment of choice.

RECOMMENDATIONS

- **Level 1**
  - In the hemodynamically stable patient, with suspected splenic injury, IV contrast-enhanced CT remains the gold standard diagnostic examination due to its speed, widespread availability, diagnostic accuracy, and relatively noninvasive nature.
  - In the hemodynamically unstable trauma patient with suspected splenic injury, a positive FAST scan or peritoneal signs requires emergent abdominal exploration to determine the source of intraperitoneal hemorrhage.
- **Level 2**
  - Non-operative management in hemodynamically stable patients with blunt splenic injury is considered standard of care.
  - Angioembolization should be performed on all hemodynamically stable patients with contrast blush on CT scan of the abdomen.
  - Routine angiography and embolization should be performed on hemodynamically stable patients with Grade IV-V splenic injury.
- **Level 3**
  - Angiography may be used as an investigative tool to identify vascular abnormalities in patients who have sustained splenic injury that have a continued drop in hemoglobin who remain hemodynamically stable, or pose a risk for delayed hemorrhage

INTRODUCTION

With regard to blunt trauma, the spleen is considered the most commonly injured intra-abdominal organ, accounting for up to 45% of all visceral injuries. Prior to the advent of CT scanning, physical examination and diagnostic procedures such as diagnostic peritoneal lavage (DPL) were the methods to guide surgical decision making. Minor splenic injury was frequently missed, while major injury in the setting of hemodynamic instability and physical findings prompted emergent laparotomy.

In early reports dated to the 1900s, immediate splenectomy was the standard of care for any degree of splenic injury, a course of action that may have been influenced by previous assertions that the spleen is physiologically unnecessary. Many studies, including one of King and Shumacker in 1952, demonstrated

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

the importance of the spleen in immunity and the increased risk of infection among splenectomized patients (1). There were also misconceptions stemming from reports in the early part of the last century that non-operative management (NOM) resulted in both a 90–100% mortality rate and a significant risk of delayed splenic rupture. However, reports in the literature as early as 1939 described evidence of healed splenic injuries at autopsy. Despite such reports, and various pioneering surgical attempts at splenic salvage, splenectomy remained the standard of care through the early 1970s. This led in recent decades to a more conservative approach in the management of splenic injuries. NOM of splenic trauma in children was reported in 1968 by Upadhyaya, followed by other authors in the 1980s that have demonstrated good results with this method (2).

Hemodynamic instability historically has been the primary reason for operative management of splenic trauma. The definition of hemodynamic instability varies, with many defining this as either a systolic blood pressure less than 90 mm Hg, need for ongoing resuscitation, or patients felt to have other associated injuries requiring operative management.

In the 1990s, CT scans became the gold standard for the diagnosis of solid organ injuries; this modality permitted identification of concomitant injuries, grading of splenic injuries and broad quantification and imaging based comparisons of degrees of hemoperitoneum (3). Further, the introduction of angioembolization increased the options available for splenic salvage.

To standardize the reporting of splenic injuries, in 1994 the Organ Injury Scaling Committee of the American Association for the Surgery of Trauma (AAST) developed a grading system based on the anatomic disruption of the spleen, as shown on CT scans or during laparotomy. The grading system is as follows.

- **Grade I**
  - Hematoma: subcapsular, <10 percent of surface area
  - Laceration: capsular tear <1 cm in depth into the parenchyma
- **Grade II**
  - Hematoma: subcapsular, 10 to 50 percent of surface area
  - Laceration: capsular tear, 1 to 3 cm in depth, but not involving a trabecular vessel
- **Grade III**
  - Hematoma: subcapsular, >50 percent of surface area OR expanding, ruptured subcapsular or parenchymal hematoma OR intraparenchymal hematoma >5 cm or expanding
  - Laceration: >3 cm in depth or involving a trabecular vessel
- **Grade IV**
  - Laceration involving segmental or hilar vessels with major devascularization (i.e., >25 percent of spleen)
- **Grade V**
  - Hematoma: shattered spleen
  - Laceration: hilar vascular injury which devascularizes spleen

Technologic improvements have increased the accuracy of CT in identifying major splenic injuries. Active splenic hemorrhage is usually seen on current contrast-enhanced CT scans as an irregular or linear area of contrast extravasation. This may be seen in the splenic parenchyma, subcapsular space or in the peritoneum. A study in 2006 found that CT had a sensitivity of 100%, specificity of 88% and overall accuracy of 93% in predicting the need for intervention (3). Authors of more recent studies advocate more selective use of angiography and embolization in the presence of the following CT findings: active contrast extravasation, splenic vascular injuries, AAST grade III–V injury and large hemoperitoneum.

Several authors, most notably Sclafani, and Haan have each proposed mandatory admission angiography for all hemodynamically stable patients with splenic injuries (4,5). This was later found to be an over-utilization of angiography due to the low incidence of non-operative failure rates on Grade I-II injuries. Grade III has remained somewhat of gray area, with new research mandating routine angiography and embolization for Grade IV-V splenic injuries in hemodynamically stable patients.

LITERATURE REVIEW

Many studies including both pediatric and adult data have demonstrated the non-operative management options in traumatic blunt splenic injury. In 1968, Upadhyaya and Simpson, based on a well-designed clinical analysis of 52 children admitted to the Hospital for Sick Children made a convincing argument for conservative management (2). In 1971, Upadhyaya et al. presented results of a corroborative experimental study, which provided the conclusive evidence that isolated splenic tears are well tolerated and heal spontaneously by first intention (2). This experience in the pediatric trauma population later evolved with several studies in the 1990s corroborating the use of non-operative management in hemodynamically stable blunt splenic injury (6).

In 1995, Sclafani et al. first described the use of embolization for blunt splenic injury (4). One hundred fifty of 172 consecutive patients (87%) with CT-diagnosed splenic injury were stable enough to be considered for non-operative management. All splenic injury grades had diagnostic angiography. Sixty patients underwent transcatheter embolization, and the overall splenic salvage rate was 98.5%, the highest salvage rate with or without embolization reported to-date. Eighty-seven of the 90 patients managed by bed rest alone, and 56 of 60 patients treated by splenic artery occlusion and bed rest had a successful outcome. Overall splenic salvage was 88% with a rate of 97% among those managed non-operatively including 61 Grade III and Grade IV splenic injuries. Sixty percent of patients received no blood transfusions.

Furthermore, in a study by Haan et al. at Maryland Shock Trauma Center, immediate operative vs. non-operative management was reviewed (7). This group was then subdivided into those undergoing immediate operative therapy vs. those receiving planned non-operative management. Unlike the Sclafani study, Haan et al. found only minimal utility in the use of angiography for lower grade injuries (i.e., AAST splenic injury Grades 1 and 2) (4). Because of this, the protocol was modified to a more selective use in those with vascular injuries. They used angioembolization in splenic injury Grades III, IV, and V, as 23% of patients embolized had no signs of vascular injury on admission abdominal CT scan. Hemodynamic instability was the primary reason for operative therapy. Under the modified protocol, hemodynamic instability was defined as a systolic blood pressure less than 100 mmHg, need for ongoing resuscitation, or patients felt to have other associated injuries requiring operative management. 386 patients underwent planned non-operative management; 126 patients underwent admission angiography during the first 2.5 years, whereas the remaining patients underwent angiography only for evidence of splenic vascular injury or AAST splenic injury Grade III to V. The mean age of the total patient group was 32 years. Seventy-six percent were male and 80% were white. Eight percent of patients suffered significant traumatic brain injury (Glasgow Coma Scale score of 8 at admission) and 8% were hemodynamically unstable at the time of admission. Mean AAST splenic injury grade was 2.8 and mean Injury Severity Score was 17. The predominant mechanisms of injury were motor vehicle collisions (84%), followed by assaults (6%). The overall splenic salvage rate was 94%. Splenic salvage decreased with increasing splenic injury grade, but higher grade injuries (Grades IV and V) still had a greater than 80% salvage rate.

In comparison to studies that were evaluating the use of embolization for non-operative treatment strategies, The EAST multicenter study did not involve splenic embolization (8). This study demonstrated an overall failure rate of 10.8% for non-operative management, and even higher rates for high-grade injuries (19.6% for Grade III, 33.3% for Grade IV and 75.0% for Grade V) (9).

In a 2011 meta-analysis by Requarth et al., angioembolization was studied, and they found no significant decrease in the failed non-operative management rate of low grade injuries (I-III) with the application of routine angioembolization. However significant reduction of failure was demonstrated with the application of angioembolization to Grade IV-V injuries (10). In 2012, Skattum et al. reported similar findings in their protocol utilizing routine angioembolization in all hemodynamically stable patients with Grade III-V blunt splenic trauma. They concluded that routine angioembolization of high grade (Grade IV-V) patients resulted in an overall successful non-operative management of 95%. Mandatory angioembolization of Grade III injuries was not justified.

Furthermore, in 2014 Requarth, Miller et al. published the result of a prospective study where all hemodynamically stable blunt splenic trauma patients with Grade III-V splenic injuries underwent angiograms (11). Comparison was then made to his previous protocol where angioembolization was only performed for identified contrast blush, to the newer protocol where angioembolization was routinely performed for all Grade III-V injuries. This demonstrated a reported significant decrease in the rate of non-operative failure (15% vs. 5%, p=0.04).

In recent years, the routine use of angiography and splenic embolization among all blunt trauma patients, as advocated in Sclafani et al., has been compared to more selective use in patients with higher grade injuries. Unnecessary angiograms were primarily in the low grade injuries (Grade I-II) resulting in additional cost and risk to the patient while providing little clinical benefit. Bhullar et al. studied such a more selective strategy which utilized angiography only for those with contrast blush on admission CT. However, high grade (Grade IV-V) injuries without CT blush still had a 26% failure rate, leading to a recommendation for operative intervention in this group of patients (12). This non-operative failure rate was re-evaluated in a recent study by Bhullar et al. Analysis revealed that high failure rates in Grade IV-V injuries may be due to failure of CT scans to identify active bleeding. They performed routine proximal main splenic artery embolization on all patients with Grade IV-V injury despite 10-15% showing no extravasation during the angiogram.

To further the argument for non-operative management in Grade I-V, Bhullar et al. has demonstrated the successful non-operative management of patients with hemodynamically stable Grade IV and V splenic injuries (13). A total of 712 hemodynamically stable adult patients with blunt splenic injury underwent NOM from 2000 to 2014. Patients were divided into two groups based on an angioembolization protocol. Failure rates of non-operative management (FNOM) were compared between two groups. The first group included routine angioembolization (RAE) utilized from 2011-2014 with angioembolization for all high grade (Grade IV-V) injuries and all injuries with contrast blush (Grade I-V). This was compared to a selective angioembolization (SAE) protocol (2000-2010) that only utilized angioembolization for injuries with blush depicted on CT. The overall failure rates for Grade I-V as well as the failure for low grade (Grade I-III) and high grade (Grade IV-V) injuries were compared for the two groups.

There was no significant difference in the FNOM between the two protocols (SAE vs. RAE) for low grade injuries (Grade I-III) (SAE vs. RAE, 2% vs. 0%, p=0.21). With the RAE protocol, unnecessary angiograms were avoided in 113 Grade I-III injuries with no contrast blush and none failed. This data supports the exclusion of Grade III from routine angiograms. However, there was a significantly lower FNOM rate for the high grade (Grade IV-V) injuries (SAE vs. RAE, 19% vs. 3%; p=0.01). When the FNOM rates were stratified and compared by individual grade, Grade IV (SAE vs. RAE, 15% vs. 2%; p=0.03) achieved significance; Grade V (SAE vs. RAE, 27% vs. 8%; p=0.25) showed a marked drop in the FNOM rate, but did not achieve statistical significance. This was believed to be due to lack of power and small number of patients (13,14).

With the RAE protocol utilizing routine angioembolization for all patients with contrast blush and those with high grade (Grade IV-V) injuries, the overall FNOM rate was significantly decreased (SAE vs. RAE, 4% vs. 1%; p=0.04). This is one of the lowest overall FNOM rates reported and is similar to the previous low failure rate of 1.5% achieved by Sclafani et al. in 1995 with routine angioembolization of all patients with blunt splenic trauma. In comparing the trend in the failure rate of non-operative management for high grade (Grade IV-V) injuries, we have seen a general decrease in failure rates with the use of embolization. Beginning with the EAST trial, which had 0% embolization and 45% failure, a SAE protocol which had 56% embolization and 19% failure; and a RAE protocol, which had 100% embolization and 3% failure, data supports the RAE protocol, utilizing routine embolization of all high grade (Grade IV-V) injuries, can significantly reduce the failure rate (3%) to allow for safe observation of these patients without surgery (9,12-14).

CONCLUSION

Based on current literature, an algorithm can be utilized to discern management between hemodynamically stable and unstable patients who have sustained blunt splenic injury. In centers with angiographic embolization capability, a more defined non-operative strategy can be utilized in hemodynamically stable blunt splenic injury patients. Routine angiographic embolization is particularly beneficial in injuries of AAST Grade IV-V, which have a high non-operative failure rate without angioembolization intervention. Clinical and CT-based criteria can be used effectively to triage patients between simple observation, angioembolization and surgery. The success of non-operative management is based on good teamwork among surgeons and radiologists, as well as judicious selection of patients who meet this criteria. Guidelines are available to assist surgeons in making a decision, however the ultimate decision in which to manage a patient lies in the experience and hands of the surgeon.

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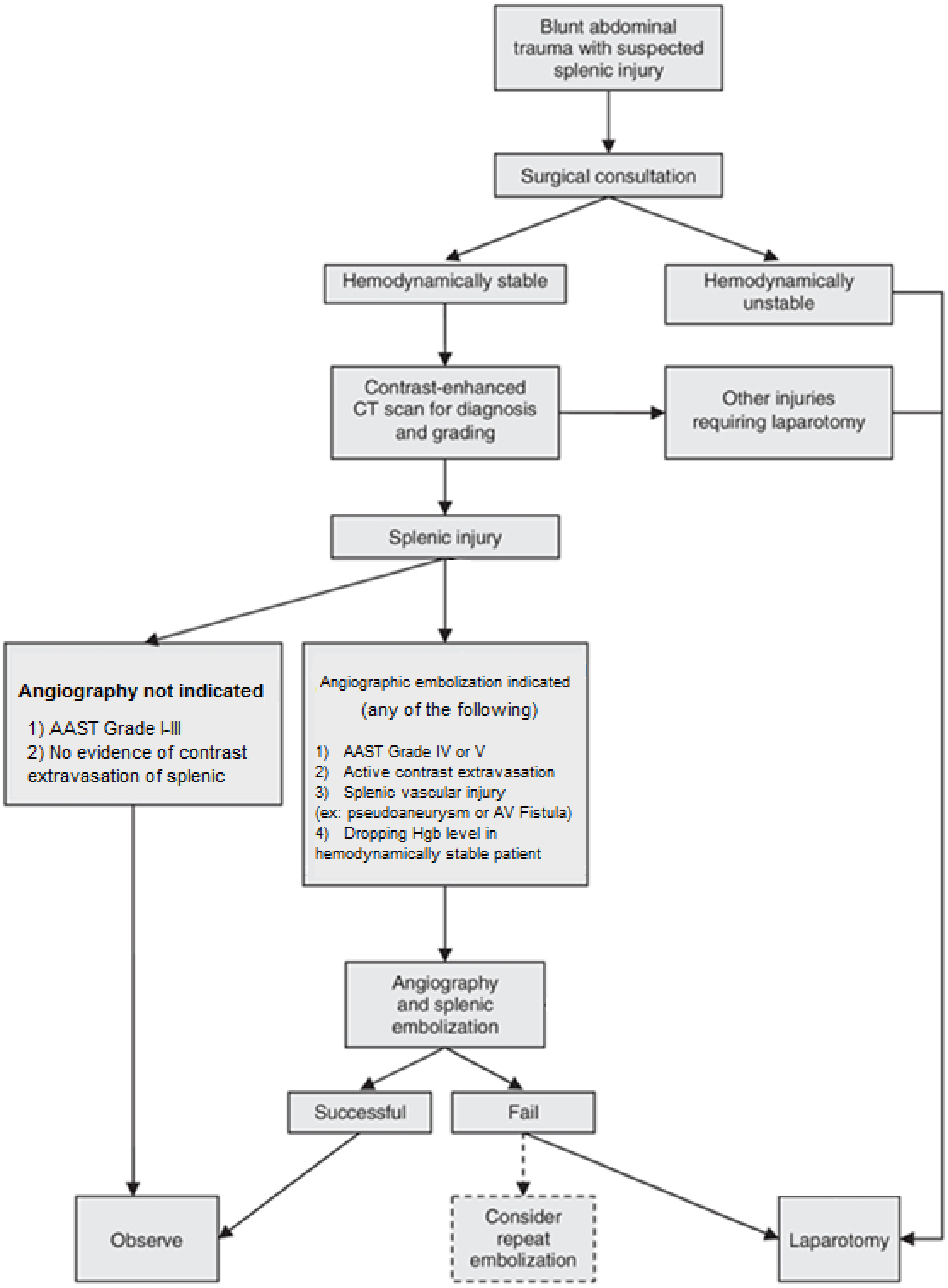
Algorithm for the Evaluation and Management of Blunt Splenic Injury


Blunt abdominal trauma with suspected splenic injury
Surgical consultation
Hemodynamically stable
Hemodynamically unstable
Contrast-enhanced CT scan for diagnosis and grading
Other injuries requiring laparotomy
Splenic injury
Angiography not indicated
1) AAST Grade I-III
2) No evidence of contrast extravasation of splenic
Angiographic embolization indicated
(any of the following)
1) AAST Grade IV or V
2) Active contrast extravasation
3) Splenic vascular injury
(ex: pseudoaneurysm or AV Fistula)
4) Dropping Hgb level in hemodynamically stable patient
Angiography and splenic embolization
Successful
Fail
Observe
Consider repeat embolization
Laparotomy