# 96 Splenic Trauma

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## 96.1 Introduction

**Learning Goals**

- To understand the AAST and WSES classification of splenic injury.
- To be able to recognize patients suitable for nonoperative management [NOM] and understand the nuances of NOM.
- To have a good grasp on the latest evidence regarding angioembolization and its role in NOM.
- To understand the indications for splenectomy.

## 96.2 Epidemiology

There is currently no consensus on the overall incidence of splenic injury. According to a European study, the incidence of blunt splenic injury is low, but it accounts for significant mortality [1]. Studies from the United States show that the overall mortality of blunt splenic injury varies from an average of 8.2 to 13% from 1981 to 2000 [2]. In a Taiwanese study, the incidence of blunt splenic injury was also not common (8.33 per million/year), with injured patient numbers being consistent every year [3].

## 96.3 Etiology

The spleen is typically injured when there is trauma involving the lower left chest or the upper left abdomen [4, 5], primarily because of its juxtaposition in the left upper abdomen to the 9th, 10th, and 11th ribs.

The three mechanisms of injury:

- Penetrating trauma, e.g. abdominal gunshot wounds.
- Blunt trauma, e.g. a punch or kick to the abdomen.
- Indirect trauma, e.g. a tear in the splenic capsule during colonoscopy or traction on the splenocolic ligament.

Most mechanisms of injuries are similar between children and adults. These include motor vehicle crashes and pedestrian accidents. Conversely, certain mechanisms of injury such as motorcycle accidents, sports injuries, gunshots or stab-related injuries, and assaults are more frequent in adults [6].

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## 96.4 Classification

The traditional classification system is the AAST system (Table 96.1) which takes the anatomical insult as the main consideration in injury grading. However, this does not take into account the overall clinical status of the patient.

The World Society of Emergency Surgery (WSES) has recently published an updated classification, that factors the clinical picture into the management algorithm [7]. The WSES classification is as follows (Table 96.2):

- Minor (WSES class I) includes hemodynamically stable AAST grade I–II blunt and penetrating lesions.
- Moderate (WSES classes II) includes hemodynamically stable AAST grade III blunt and penetrating lesions.
- Moderate (WSES classes III) includes hemodynamically stable AAST grade IV–V blunt and penetrating lesions.
- Severe (WSES class IV) includes hemodynamically unstable AAST grade I–V blunt and penetrating lesions.

**Table 96.1** AAST classification of splenic trauma

| Grade | Injury description | |
|---|---|---|
| I | Hematoma | Subcapsular, <10% surface area |
| | Laceration | Capsular tear, <1 cm parenchymal depth |
| II | Hematoma | Subcapsular, <10–50% surface area |
| | | Intraparenchymal, <5 cm diameter |
| | Laceration | 1–3 cm parenchymal depth not involving a perenchymal vessel |
| III | Hematoma | Subcapsular, >50% surface area or expanding |
| | | Ruptured subcapsular or parenchymal hematoma |
| | | Intraparenchymal hematoma >5 cm |
| | Laceration | >3 cm parenchymal depth or involving trabecular vessels |
| IV | Laceration | Laceration of segmental or hilar vessels producing major devascularization (>25% of spleen) |
| V | Laceration | Completely shatters spleen |
| | Vascular | Hilar vascular injury which devascularized spleen |

**Table 96.2** WSES classification of splenic trauma

| | WSESclass | Mechanism of injury | AAST | Hemodynamic status[a, b] | CT scan | First-Line treatment in adults | First-Line treatment in pediatric |
|---|---|---|---|---|---|---|---|
| Minor | WSES I | Blunt/ penetrating | I–II | Stable | Yes + local exploration in SW[d] | NOM[c] + serial clinical/ radiological evaluation Consider angiography/ angioembolization | NOM[c] + serial clinical/ radiological evaluation Consider angiography/ angioembolization |
| Moderate | WSES II | Blunt/ penetrating | III | Stable | | | |
| | WSES III | Blunt/ penetrating | IV–V | Stable | | NOM[c] All angiography/ angioembolization + serial clinical/ laboratory/radiological evaluation | |
| Severe | WSES IV | Blunt/ penetrating | I–V | Unstable | No | OM | OM |

*SW* stab wound, *GSW* gunshot wound

[a] *Hemodynamic instability in adults* is considered the condition in which the patient has an admission systolic blood pressure <90 mmHg with evidence of skin vasoconstriction (cool, clammy, decreased capillary refill) and an altered level of consciousness, or a blood pressure >90 mmHg but requiring bolus infusions/transfusions and/or vasopressor drugs and/or admission base excess (BE) > – 5 mmol/L and/or shock index >1 and/or transfusion requirement of at least 4–6 units of packed red blood cells within the first 24 h. Conversely, transient responders are those patients who show an initial response to fluid resuscitation, and thereafter still have signs of ongoing loss and perfusion deficits.

[b] *Hemodynamic stability in pediatric patients* is considered as having a systolic blood pressure of 90 mmHg plus twice the child's age in years (the lower limit is inferior to 70 mmHg plus twice the child's age in years, or inferior to 50 mmHg in some studies). Stabilized or acceptable hemodynamic status is considered in children with a positive response to fluid resuscitation: 3 blouses of 20 mL/kg of crystalloid replacement should be administered before blood replacement; positive response can be indicated by the heart rate reduction, the sensorium clearing. the return of peripheral pluses and normal skin color, an increase in blood pressure and urinary output, and an increase in warmth of extremity. Clinical judgement is fundamental in evaluating children

[c] NOM should only be attempted in centers capable of a precise diagnosis of the severity of spleen injuries and capable of intensive management (close clinical observation and hemodynamic monitoring in a high dependency/intensive care, including serial clinical examination and laboratory assay, with immediate access to diagnostics, interventional radiology, and surgery and immediately available access to blood and blood products or alternatively in the presence of a rapid centralization system in those patients amenable to be transferred

[d] Wound exploration near the inferior costal margin should be avoided if not strictly necessary because of the high risk to damage the intercostal vessels

## 96.5 Diagnosis

### 96.5.1 Clinical Presentation

Patients will present with a history of trauma, abdominal pain, and varying stages of shock.

### 96.5.2 Diagnostic Imaging

1. Extended focused assessment sonography for trauma (E-FAST) has replaced diagnostic peritoneal lavage (DPL) in the management of abdominal trauma [8–10]. Studies have shown a sensitivity of up to 91% and a specificity of up to 96% for a small fluid amount [11, 12]. The E-FAST can detect the presence of free fluid and can also provide an ultrasonographic image of the spleen itself. Moreover, the E-FAST is readily available at the bedside, thus increasing its utility and applicability.
2. Contrast tomography (CT) scan is considered the gold standard in trauma with a sensitivity and specificity for splenic injuries near to 96–100% [9, 13, 14]. However, hilar injuries may be underestimated [9]. The main considerations prior to using the CT scanner, are that the

scanner must be rapidly available and must be performed only in hemodynamically stable patients or in those responding to fluid resuscitation [15, 16]. The CT scan is particularly useful as it can help delineate the anatomy of the injured spleen, which helps in the AAST grading of the injury. The delayed phase can also further differentiate patients with active bleeding from those with contained vascular injuries [17].

The identification of an active contrast extravasation is a classic sign of active hemorrhage [18]. Contrast blush occurs in about 17% of cases and has been demonstrated to be an important predictor of failure of NOM (>60% of patients with blush failed NOM). However, the absence of a blush on the CT scan in high-grade splenic injuries does not definitively exclude active bleeding and should not preclude angioembolization [13, 19, 20].

## 96.6 Management

### 96.6.1 Nonoperative Management (NOM) for Blunt Splenic Trauma

For hemodynamically stable patients, with the absence of other abdominal organ injuries that require surgery, these patients should undergo a trial of NOM regardless of injury grade [13, 21–24]. The caveat is that the hospital must have the capability for intensive monitoring, facilities and expertise for angioembolization, the ready access to available operating theatres, and immediate access to blood products. The presence of a CT scanner is paramount, as a baseline CT scan with intravenous contrast is necessary to define the anatomical splenic injury and to identify associated injuries.

The success rate of NOM in such circumstances is approximately 90% [25]. The advantages of NOM include reduced hospital costs, avoidance of nontherapeutic laparotomies, lower rates of blood transfusions, lower mortality, and the prevention of overwhelming post-splenectomy infection [OPSI] [23, 26, 27]. Routine laparotomy in hemodynamically stable patients with blunt splenic injury is not indicated [28, 29].

Risk factors for NOM failure include age > 55 years old, high ISS, and moderate to severe splenic injuries [15, 37, 40]. Other relative risk factors for NOM failure include age > 55 years old alone, large hemoperitoneum alone, hypotension before resuscitation, GCS < 12, low hematocrit level upon admission, associated abdominal injuries, blush at CT scan, anticoagulation drugs, HIV disease, drug addiction, cirrhosis, and need for blood transfusions [13, 17, 18, 25, 30–40].

An exception however exists for patients with WSES classes II–III spleen injuries with associated severe traumatic brain injury. In these patients, NOM could be considered only if absolutely efficient and rapid rescue therapy is available; otherwise, splenectomy should be performed.

### 96.6.2 Nonoperative Management (NOM) for Penetrating Trauma

Laparotomy has been the gold standard in penetrating abdominal trauma [e.g., gunshot and stab wounds]. Overall, the rate of negative laparotomy ranges between 9% and 14% [41, 42] in these cases. However, if the patient is found to have concomitant pancreatic, diaphragmatic, colic, and splenic injuries, they tend to have a significantly increased mortality rate [43]. The associated pancreatic injuries also frequently require spleno-pancreatectomy [43]. Although there is a trend toward adopting NOM for gunshot and stab injuries [44, 45], the decision for NOM in penetrating trauma should be still decided on a case-by-case basis.

### 96.6.3 Role of Angiography and Angioembolization [AG/AE] in NOM

The main indications for AG/AE are [46–48]:

1. WSES I and II patients who have vascular injuries detected via CT scan (contrast blush, pseudo-aneurysms, and arteriovenous fistula). Hemodynamically stable patients with WSES class I and II lesions without blush should not

undergo routine AG/AE but may be considered for prophylactic proximal embolization in presence of risk factors for NOM failure.
2. WSES III patients who are hemodynamically stable regardless of the presence of CT blush.
3. Patients who are stable with signs of persistent hemorrhage regardless of the absence of CT blush once extra-splenic source of bleeding has been excluded.

Some considerations during AG/AE:

1. In presence of a single vascular abnormality (contrast blush, pseudo-aneurysms and arteriovenous fistula) in minor and moderate injuries, it is unclear whether proximal or distal embolization should be adopted [49]. Both methods were found to be similar with regard to the incidence of major infarctions, infections, and major rebleeding [50].
2. In presence of multiple splenic vascular abnormalities or in presence of a severe lesion, proximal or combined AG/AE should be used, after confirming the presence of a permissive pancreatic vascular anatomy. Or in the absence of blush during angiography, if a blush was previously seen at CT scan, proximal angioembolization could be considered.
3. In performing AG/AE, coils should be preferred to temporary agents.
4. Conversely, when AG/AE is not rapidly available or in event of rapid hemodynamic deterioration, surgery should be considered.

The reported success rate of NOM with AG/AE ranges from 86 to 100% [46–48, 51–58]. AG/AE reduces the odds of splenectomy, with better results, the earlier the AG/AE was performed [58, 59]. Meta-analyses have shown a significant improvement in NOM success following introduction of AG/AE protocols (OR 0.26, 95% CI 0.13–0.53, $p < 0.002$) [37, 60–62].

Between 2.3 and 47% CT detected, contrast blushes could not be confirmed during angiography [63, 64]. Moreover an analysis on 143 patients with blush at CT scan suggested that an angiographic procedure without embolization increases twofold the risk of rebleeding and NOM failure [64].

The use of routine prophylactic AG/AE in high-grade splenic injuries is controversial [19, 46, 48, 54, 65–68]. NOM failure rates both with and without prophylactic AG/AE for high-grade injuries are 0–42% vs. 23–67%, respectively [19, 46, 48, 54, 65, 66]. Controversies exist regarding which kind of lesions should be considered as "high-grade" (AAST III–V or IV–V grade) and should undergo routine AG/AE [19, 46, 67, 68]. It has been reported that NOM could fail in up to 3% of grade III lesions without blush, with no AG/AE [19]. Considering the AG/AE-related morbidity of 47% (versus 10% related to NOM without AG/AE) [68], patients with grade III lesions without blush should not undergo routine AG/AE.

AG/AE major morbidity rates range from 3.7 to 28.5% including rebleeding, splenic infarction, splenic abscesses, acute renal insufficiency, pseudocysts, and puncture-related complications [19, 46, 48, 69–76]. The rates for minor morbidities range from 23 to 61% and include fever, pleural effusion, and coil migration [48, 69, 75, 76]. Comparatively, patients undergoing OM still reported significantly higher complication rates as compared to those who had AG/AE [68, 70, 71, 74].

AG/AE does not seem to totally compromise the splenic function, and, even in presence of an elevated leukocyte and platelet counts, no significant differences in immunoglobulin titers were found between splenic artery AG/AE patients and controls [66]. The spleen due to its intense vascularization, can maintain the necessary bloodflow to continue its immunological function.

### 96.6.4 Operative Management (OM)

The main indications of OM include:

1. Patients with hemodynamic instability or with associated lesions like peritonitis or bowel evisceration requiring surgical exploration. The severity of splenic injury seems to be related to the incidence of hollow viscus injury (1.9, 2.4, 4.9, and 11.6% in minor, moderate, major, and massive injuries, respectively) [77].
2. OM should be performed in moderate and severe lesions even in stable patients, in cen-

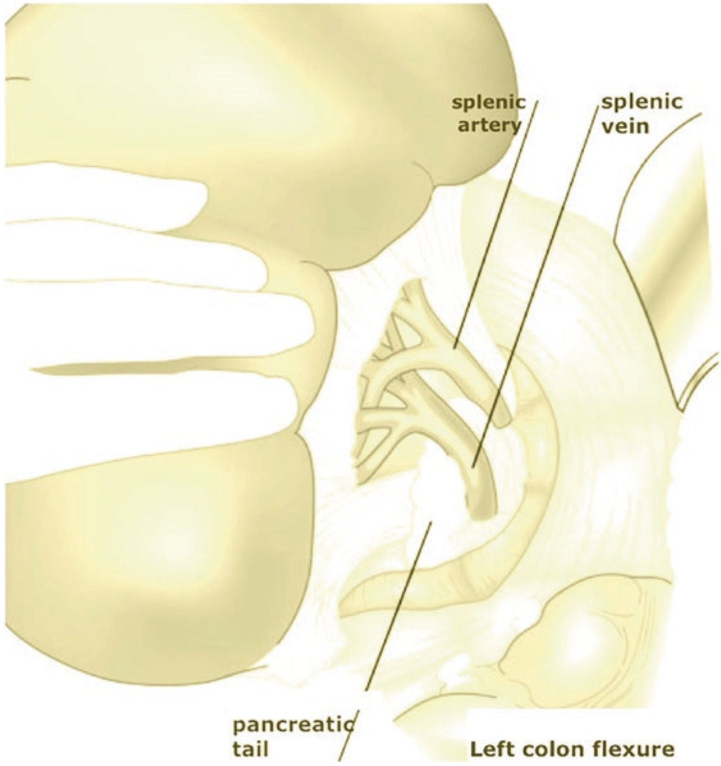


**Fig. 96.1** Open splenectomy

ters where intensive monitoring cannot be performed and/or when AG/AE is not rapidly available [78, 79].

3. When NOM with AG/AE fails and patient remains hemodynamically unstable or shows a significant drop in hematocrit levels or continuous transfusion is required, OM is also indicated.

During OM, salvage of a part of the spleen is controversial [80, 81]. The use of splenic autologous transplantation—leaving pieces of spleen inside the abdomen—to avoid infective risk from splenectomy has not been shown to reduce morbidity or mortality [82]. Overall mortality of splenectomy in trauma is approximately 2%, and the incidence of postoperative bleeding after splenectomy ranges from 1.6 to 3%, but with mortality near to 20% [83]. Laparoscopic splenectomy in bleeding trauma patients is not recommended, and open splenectomy is mandatory [84, 85] (Fig. 96.1).

WSES spleen trauma management algorithm for adult patients is reported in Fig. 96.2.

### 96.6.5 Thromboprophylaxis in Splenic Trauma

Trauma patients are at high risk of venous thromboembolism (VTE). The transition to a hypercoagulation state occurs within 48 h from injury [86–88]. For patients who survive beyond the first 24 h, pulmonary embolism (PE) is the third leading cause of death. Even with chemical prophylaxis, deep venous thrombosis (DVT) can be detected in 15% of patients. If this progresses to PE, the mortality is about 50% [86, 87].

DVT prophylaxis is paramount in trauma patients. Mechanical prophylaxis is very safe and should be considered in all patients without absolute contraindication to its use.

Regarding chemical prophylaxis, it is best to consider using LMWH-based prophylactic anticoagulation. Splenic trauma without ongoing bleeding is not an absolute contraindication to this. If anything, prophylactic anticoagulation should be started as soon as possible from trauma [120]. Bellal et al. [89] found no difference in hemorrhagic complication and NOM failure rate in patients with

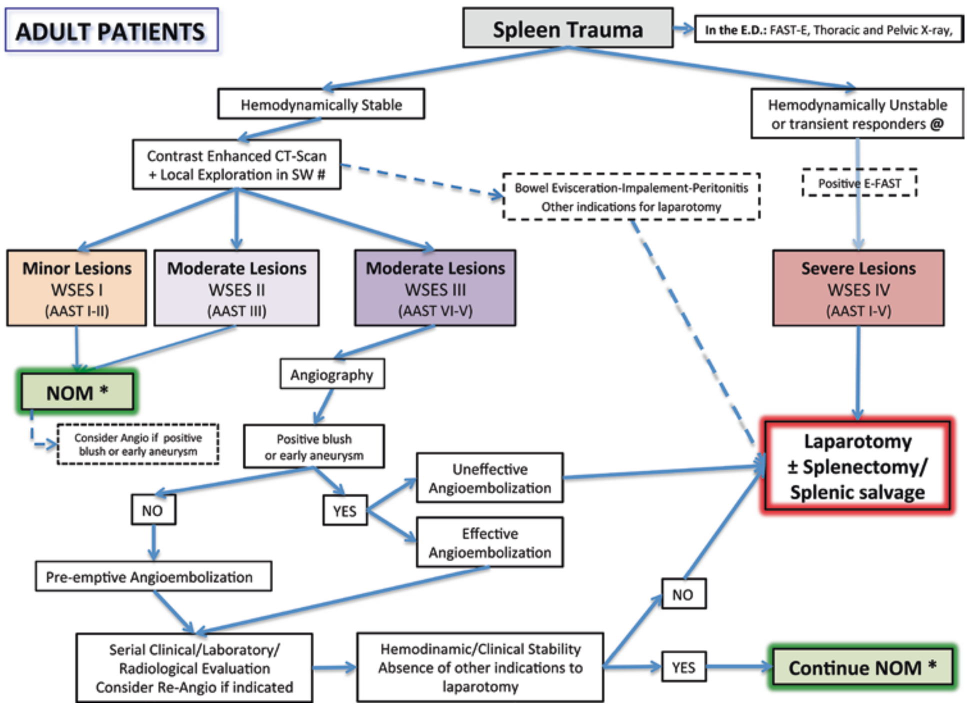


**Fig. 96.2** WSES spleen trauma management algorithm for adult patients

early (< 48 h), intermediate (48–72 h), and late (> 72 h) VTE prophylaxis. Rostas et al. [86] show that VTE rates were over fourfold greater when LMWH was administered after 72 h from admission. Pertaining to oral anticoagulants, the risk-benefit balance of reversal should be individualized. Failing to resume anticoagulation in a timely fashion is associated with poor outcomes [90].

## 96.7 Prognosis: Short- and Long-Term Follow-up for NOM

Complete bed rest for the first 48-72hours, is the cornerstone of NOM treatment for patients with moderate and severe splenic traumatic lesions [16]. 19% of splenic-delayed ruptures happen within the first 48 h, with the majority of delayed ruptures occuring most frequently between 4 to 10 days after the trauma. Patients can present for a delayed splenectomy after discharge, anytime between 3 and 146 days after injury, and the rate of readmission for splenectomy was 1.4% [91] with approximately 2% of patients requiring late intervention [92].

Savage et al. [92] found an average of healing time of 12.5 days for patients with grades I–II splenic injury, with a complete healing after 50 days. Conversely patients with grades III–V injuries required 37.2 and 75 days respectively. In 2–2.5 months, regardless of the severity of the splenic injury, 84% of patients had complete healing [92]. Crawford et al. suggested that an early discharge is safe because late failure occurs infrequently [39, 93]. Nonetheless, the mortality of delayed rupturse range from 5 to 15% compared with 1% mortality in cases of acute rupture [31, 94]. In any case, patients who have undergone NOM should be counseled to not remain alone or in isolated places for the first weeks after the discharge, and they should be warned about the red flag symptoms to watch out for.

Repeated CT scans during the admission should be considered in patients with moderate or severe lesions, or those with decreasing hematocrit, or patients who were found to have vascular anomalies or underlying splenic pathologies or coagulopathies, and in neurologically impaired patients. However, there is no consensus regarding the timing and type of imaging (CT vs. US) [16, 31, 95–

98]. More than 50% of patients demonstrated healing at an interval follow-up CT scan after 6 weeks, and subsequent further scans seemed to have no additional clinical utility [99]. However, routine post-discharge follow-up abdominal CT is not necessary in low-grade (AAST grade I or II) injuries [96].

Activity restriction may be suggested for 4–6 weeks in minor injuries and up to 2–4 months in moderate and severe injuries [92, 98, 100, 101]. Complete healing of almost all grades is observed 3 months after injury. The role of radiological follow-up before returning to normal activity remains controversial overall.

## 96.8 Pediatric Splenic Trauma (<15 Years Old)

The spleen is the most commonly injured solid organ in pediatric blunt trauma (25–30%) [6, 102]. The Eastern Association for the Surgery of Trauma (EAST) recommends NOM in blunt splenic trauma in all hemodynamically stable children irrespective of the AAST injury grade [103, 104].

NOM seems to be more effective in children [105] and is associated with reduced costs and lengths of hospital stay, less need for blood transfusions, vaccinations, and antibiotic therapy, as well as higher immunity and reduced rate of infections [106–110]. Even though it is not clear why NOM outcomes are superior in children compared with adults, this phenomenon may be related to certain unique pediatric characteristics (e.g., thicker splenic capsule, higher proportion of myoepithelial cells, more efficient contraction, and retraction of the splenic arterioles [111–116]).

WSES spleen trauma management algorithm for pediatric patients is reported in Fig. 96.3.

### 96.8.1 Diagnostic Procedures

*Contrast-enhanced computer tomography (CT)* is the gold standard for the evaluation of blunt abdominal trauma [6, 8]. However, patients

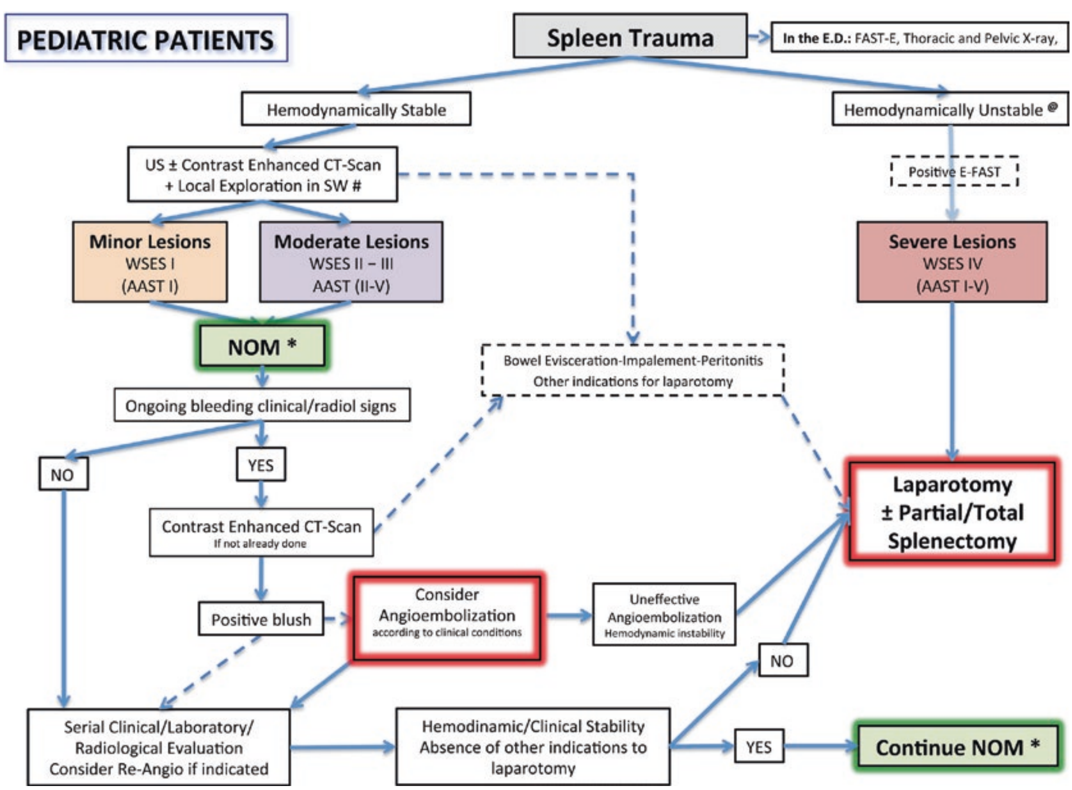


**Fig. 96.3** WSES spleen trauma management algorithm for pediatric patients

should be hemodynamically stable as well as cooperative or sedated. Of note, surgeons should interpret CT findings cautiously before opting for OM because more than 50% of children present with grade III–IV lesions [6].

*FAST (Focused Assessment with Sonography for Trauma)*: The role of FAST for the diagnosis of spleen injury in children is still unclear. The sensitivity of this imaging modality in children ranges from 50 to 92% [117–119]. The specificity of this exam is also quite low, and, therefore, in a hemodynamically stable patient, a positive FAST examination should be followed by an urgent CT. Bedside FAST may have utility in hemodynamically unstable patients to rapidly identify or rule out intraperitoneal hemorrhage when patients cannot undergo CT.

### 96.8.2 Nonoperative Management in Splenic Injury

NOM is recommended as first-line treatment for hemodynamically stable pediatric patients with blunt splenic trauma [105]. Patients with moderate-severe blunt and all penetrating splenic injuries should be considered for transfer to dedicated pediatric trauma centers after stabilization.

NOM of splenic injuries in children should be considered only in an environment that has the capability for patient continuous monitoring, angiography, trained surgeons, an immediately available OR, and immediate access to blood and blood products or alternatively in the presence of a rapid centralization system in those patients amenable to be transferred [120, 121]. NOM should be attempted even in the setting of concomitant head trauma, unless the patient is unstable due to intra-abdominal bleeding.

In particular, for blunt splenic injuries with hemodynamic stability and absence of other internal injuries requiring surgery, these patients should undergo an initial attempt of NOM irrespective of injury grade. The presence of contrast blush at CT scan is not an absolute indication for splenectomy or AG/AE in children. Intensive care unit admission in isolated splenic injury may be required only for moderate and severe lesions [122].

However, no sufficient data validating NOM for penetrating spleen injury in children exist. However, reports on successful nonoperative management of isolated penetrating spleen injuries in hemodynamically stable pediatric patients do exist [123–125].

NOM failure rates for pediatric splenic trauma have been shown to range from 2 to 5% [126, 127]. Of note, there is evidence suggesting that the rate of NOM failure peaks at 4 h and then declines over 36 h from admission [126]. Overall, the majority (72.5%) of NOM failures seem to occur during the first week after trauma, with 50% of them happening within the first 3–5 days [128].

### 96.8.3 The Role of Angiography/Angioembolization (AG/AE)

The vast majority of pediatric patients do not require AG/AE for CT blush or moderate to severe injuries [129–131].

However, there are several potential considerations:

1. AG/AE may be considered if the patient has signs of persistent hemorrhage not amenable to NOM, once extra-splenic source of bleeding has been excluded.
2. AG/AE may be considered for the treatment of post-traumatic splenic pseudo-aneurysms prior to patient discharge.
3. Patients of more than 15 years old, or children of less than 13–15 years old that are more vulnerable to OPSI, should be managed according to adults AG/AE-protocols [132, 133].

The role of embolization in the management of pediatric splenic pseudo-aneurysms is also unclear. Of note, PSAs often undergo spontaneous thrombosis and could resolve without any interventions [97, 108, 131].

Mortality and major complications are rarely reported following AG/AE [131, 132, 134, 135]. Nevertheless, a post-embolization syndrome (PES), consisting of abdominal pain, nausea, ileus, and fever, seems to occur in 90% of children undergoing AG/AE. This syndrome is usually self-limited and tends to resolve spontaneously in 6–9 days [136]. In addition, pleural effusion (9%), pneumonia (9%), and coil migration (4.5%) can also be seen after splenic embolization [132]. Overall, AG/AE seems to preserve splenic function without lasting complications, but most children do not need this intervention [130].

### 96.8.4 Operative Management in Blunt and Penetrating Injuries

Patients should undergo OM in cases of hemodynamic instability, failure of conservative treatment, severe coexisting injuries necessitating intervention, and peritonitis, bowel evisceration, and impalement [122, 137–140].

Splenic preservation (at least partial) should be attempted whenever possible. Partial (subtotal) splenectomy or splenorrhaphy are safe and viable alternatives to total splenectomy and can be performed even in high-grade injuries [139, 141–143]. 1% of pediatric patients who undergo immediate OM are readmitted for intestinal obstruction within a year [140].

### 96.8.5 Splenic Trauma Associated with Head Injuries

Head injury is an important cause of morbidity and mortality in trauma patients of all ages (50–60%) and can also result in altered mental status, which can complicate the process of clinical evaluation [144]. Especially in the setting of concurrent head injury, blood pressure and heart rate are poor markers of hemorrhagic shock in pediatric patients [122]. Nevertheless, an analysis of the National Pediatric Trauma Registry suggested that the association of altered mental status from head injury with spleen injuries should not impact the decision for observational management in pediatric patients (< 19 years old) [144].

### 96.8.6 Short- and Long-Term Follow-Up in Splenic Trauma (Blunt and Penetrating)

In hemodynamic stable children without a drop in hemoglobin levels for 24 h, bed rest should be suggested. Initial APSA guidelines [106] recommended bed rest for a number of days equal to the grade of injury plus 1 day [106]. However, recent studies suggest a shorter bed rest of one night in solitary grade I–II splenic trauma and two nights for patients with more severe injuries (grade ≥ III) and stable hemoglobin level [145]. Longer admissions should be considered in patients with lower hemoglobin levels on admission, higher injury grade, suspected other abdominal injuries (as pancreatic or small bowel injuries), blush on the CT scan, bicycle handlebar injuries, and recurrent bleeding or patients at risk for missed injuries [122].

US (DUS, CEUS) follow-up seems reasonable to minimize the risk of life-threatening hemorrhage and associated complications in children [146].

After NOM in moderate and severe injuries, the reprise of normal activity could be considered safe after at least 6 weeks. The APSA guidelines [106] recommended 2–5 months of “light” activity before restart with normal activities and recommended 3 week–3 months of limited activity at home. In fact, the risks of delayed splenic rupture and post-traumatic pseudocysts seem to be increase within the first 3 weeks (incidence 0.2 and 0.3%, respectively) [106, 147]. Canadian guidelines suggested a discharge at home after reprise and good toleration of oral intake, able mobilization, and analgesia with oral medications; without a need for any imaging prior to discharge [148]. They reported a restriction of activities of no more than 6–8 weeks [148].

## 96.9 Infection Prophylaxis in Asplenic and Hyposplenic Adult and Pediatric Patients

Patients should receive immunization against encapsulated bacteriae (*Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis*) [149, 150]. Vaccination programs should be started no sooner than 14 days after splenectomy or splenic total vascular exclusion. In fact, before 14 days, the antibody response is suboptimal [149, 151]; after that interval, the earlier the better. In asplenic/hyposplenic patients discharged before 15 days, where the risk to miss the vaccination is deemed high, the first vaccines should be given before discharge [151, 152]. The Center for Disease Control in 2016 proposed these last updated recommendations [153].

Most episodes of severe infections occur within the first 2 years after splenectomy, and for this reason, some authors recommended at least 2 years of prophylactic antibiotics after splenectomy. However, the duration of antibiotic prophylaxis is controversial.

Ideally, the vaccinations against *S. pneumoniae*, *H. influenzae* type B, and *N. meningitidis* should be given at least 2 weeks before splenectomy [6]. Patients should be informed that immunization can only reduce the incidence of OPSI (vaccines so far available do not allow an exhaustive coverage for *S. pneumoniae*—23 of 90 serotypes are included, nor for *N. meningitidis*—5 of 6 serotypes).

Annual immunization against seasonal flu is recommended for all patients over 6 months of age [154, 155]. Malaria prophylaxis is strongly recommended for travelers. Antibiotic therapy should be strongly considered in the event of any sudden onset of unexplained fever, malaise, chills, or other constitutional symptoms, especially when medical review is not readily accessible.

OPSI is a medical emergency. The risks of OPSI and associated death are highest in the first year after splenectomy, at least among young children, but remain elevated for more than 10 years and probably for life. The incidence of OPSI is 0.5–2%; the mortality rate is from 30 to 70%, and most death occurs within the first 24 h. Only prompt diagnosis and immediate treatment can reduce mortality [6, 150, 151, 154]. Asplenic/hyposplenic children younger than 5 years old have a greater overall risk of OPSI with an increased death compared with adults [149, 155]. The risk is more than 30% in neonates [6]. Evidence exists regarding the possible maintainence of function by the embolized spleen (hyposplenic patients); however, it is reasonable to consider it as less effective and proceed with vaccination as well [130, 156].

Asplenic/hyposplenic patients should be given an antibiotic supply in the event of any sudden onset of unexplained fever, malaise, chills, or other constitutional symptoms, especially when medical review is not readily accessible. The recommended options for emergency standby in adults include the following: (a) amoxicillin, 3 g starting dose followed by 1 g, every 8 h; (b) levofloxacin 500 mg every 24 h or moxifloxacin 400 mg every 24 h (for beta-lactam allergic patients). The recommended emergency standby treatment in children is amoxicillin 50 mg/Kg in three divided daily doses. For beta-lactam allergic patients, an alternative should be proposed by a specialist (fluoroquinolones are generally contraindicated in children, but due to the possible severity of OPSI, they might still be considered).

**Dos and Dont's**

**Dos**

1. All hemodynamically stable patients with blunt splenic trauma should be managed nonoperatively, with angioembolization applied when indicated.
2. All unstable patients with splenic trauma should be managed operatively.
3. Stable patients with severe injuries should be considered for operative management, if angioembolization and monitoring facilities are inadequate.

**Don'ts**

1. Do not operate on pediatric patients with splenic trauma unless absolutely indicated, e.g., concomitant injuries requiring surgery.

**MCQ**

1. NOM for splenic trauma:
   A. Is always possible.
   B. **Is possible only for stable patients.**
   C. Is performed with splenectomy.
   D. Is not possible.
2. NOM for splenic trauma:
   A. Is performed in all hospitals (HUB and SPOKE).
   B. **Is performed in HUB trauma centers.**
   C. Is performed if surgical services arenot available.
   D. Is performed without interventional radiology.
3. NOM for splenic trauma:
   A. Is performed always with splenic artery embolization.
   B. **Can be performed with bed rest and close observation alone.**
   C. Is performed always with splenic artery distal embolization.
   D. Is performed always with embolization.

**Take-Home Messages**

- Nonoperative management is the first line of management for stable patients with blunt splenic trauma.
- If unstable, or if monitoring facilities are inadequate, surgical management is the first line option.
- For stable penetrating traumas, each case should be evaluated individually to decide if surgery or conservative management would be most ideal.

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## Further Reading

Coccolini, F., Montori, G., Catena, F. *et al.* Splenic trauma: WSES classification and guidelines for adult and pediatric patients. World J Emerg Surg 12**,** 40 Thursday (2017).