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ORIGINAL ARTICLE

Blunt splenic injury: are early adverse events related to trauma, nonoperative management, or surgery?

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PURPOSE
We aimed to compare clinical outcomes and early adverse events of operative management (OM), nonoperative management (NOM), and NOM with splenic artery embolization (SAE) in blunt splenic injury (BSI) and identify the prognostic factors.

METHODS
Medical records of 136 consecutive patients with BSI admitted to a trauma center from 2005 to 2010 were retrospectively reviewed. Patients were separated into three groups: OM, NOM, and SAE. We focused on associated injuries and early adverse events. Multivariate analysis was performed on 23 prognostic factors to find predictors.

RESULTS
The total survival rate was 97.1%, with four deaths all occurred in the OM group. The spleen salvage rate was 91% in NOM and SAE. At least one adverse event was observed in 32.8%, 62%, and 96% of patients in NOM, SAE, and OM groups, respectively ($P < 0.001$). We found significantly more deaths, infectious complications, pleural drainage, acute renal failures, and pancreatitis in OM and more pseudocysts in SAE. Six prognostic factors were statistically significant for one or more adverse events: simplified acute physiology score 2 ≥25 for almost all adverse events, age ≥50 years for acute respiratory syndrome, limb fracture for secondary bleeding, thoracic injury for pleural drainage, and at least one associated injury for pseudocyst. Adverse events were not related to the type of BSI management.

CONCLUSION
Patients with BSI present worse outcome and more adverse events in OM, but this is related to the severity of injury. The main predictor of adverse events remains the severity of injury.

Blunt splenic injury (BSI) has become more frequently managed nonoperatively over the years, with the results improved by the contribution of embolization, making it possible to treat active hemorrhages as well as prevent hemorrhages in high-grade trauma of the spleen without active bleeding (1–10). Three methods of splenic artery injury management can be defined: operative management (OM), nonoperative management (NOM), and nonoperative management with splenic artery embolization (SAE).

The complication rate in relation to different management methods (operative and nonoperative) continues to be debated. The description and prevalence of these complications varies greatly from one series to another (7, 11–13), resulting from the confusion existing between adverse events related to injury and those related to treatment. The severity of polytrauma is taken into account using the patients' injury severity score (ISS), and several studies have shown that a high ISS was related to more nonsurgical treatment failures (14). Certain authors have taken a specific interest in the parameters of multiple injuries and shown that lesions of associated organs (pancreas, spinal cord, limbs) were related to more complications (15–17). The severity of trauma and associated lesions could therefore be considered confounding factors resulting in treatment failure and complications. A better understanding of these complications could help in preventing them.

The objectives of this study were to compare outcomes of the three types of BSI management, determine if there are any complications statistically related to management methods, and demonstrate risk factors taking polytrauma into account.

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Methods

Population

This was a retrospective study, reviewing the medical files and imaging exams of all consecutive adult patients presenting with splenic injury between 2005 and 2010 in a single level-one trauma center. These patients were analyzed in three groups depending on how they were managed: OM group, if splenectomy was performed within the first 12 h; SAE group, if splenic artery embolization was performed during hospitalization; or NOM group, if neither splenectomy during the first 12 h nor embolization during hospitalization was performed. Local institutional review board approval was obtained.

Management algorithm

The indication for OM was attributed to any hemodynamically unstable patients, despite adequate resuscitation. The spleen injury was graded on computed tomography (CT) using the American Association for the Surgery of Trauma (AAST) classification (18): (grade 1, hematoma <10% or laceration <1 cm; grade 2, hematoma 10%–50% or laceration 1–3 cm; grade 3, hematoma >50% or laceration >3 cm with devascularization <25%; grade 4, major laceration with devascularization >25%; grade 5, comminuted fracture or complete devascularization).

The indication for SAE was recommended in cases of splenic vascular lesions on CT, spleen injury AAST grade 4–5, or AAST grade 3 with severity factors (large hemoperitoneum, age ≥50 years, severe associated lesions). However, the final management decision was left to the appreciation of the trauma team comprising an emergency care specialist, an emergency surgeon, and an interventional radiologist. The other patients received NOM. NOM or SAE failure was considered when a splenectomy was required.

Main points

- Blunt splenic injury management was complicated by at least one adverse event in 55% of the cases in our study, with more complications in operative management than in nonoperative management (with or without embolization of the splenic artery).
- Multivariate analysis suggested that adverse events were not related to the type of management, but demonstrated that the severity of trauma and associated injuries were the true risk factors.
- Adverse events should be anticipated according to the severity of trauma and associated injuries; not according to the type of management.

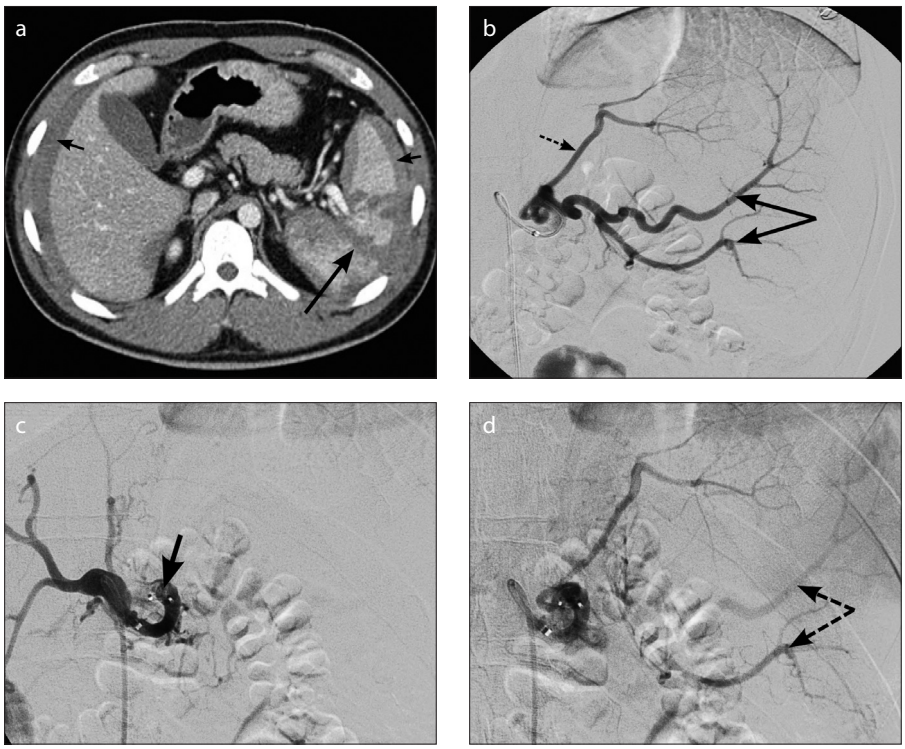

Figure 1. a–d. Proximal embolization of a splenic injury grade 3 AAST with a large hemoperitoneum. Transverse contrast-enhanced CT scan **(a)** of the spleen at a venous phase, demonstrates a laceration >3 cm *(long arrow)* with perisplenic and perihepatic hemoperitoneum *(short arrows)*. This finding is consistent with a spleen injury grade 3 AAST. Diagnostic arteriography **(b)** of the splenic artery *(double arrows)*. Note the left gastric artery arising from the coeliac trunk (*dashed arrow,* **b**). Repeat angiography **(c)** after proximal embolization with a plug *(arrow)*. At the beginning of the scan, splenic artery seems to be totally occluded. More tardive acquisition of the same angiography **(d)** shows that vascular supplies coming from collateral vessels such as the left gastric artery, return to the end of splenic artery *(double dashed arrows)*.

CT protocol

Patients who were hemodynamically stable (with or without emergency care) underwent a whole-body scan with the arterial phase on the thorax and the abdomen and a venous phase on the abdomen and the pelvis (Brillance 64 or Brillance 40, Philips Medical Systems or Sensation 16, Siemens Medical Solutions). Patients with isolated abdominal trauma underwent an abdominopelvic CT with arterial and venous phases. Patients received 100 mL of an intravenous bolus of the contrast agent lobitridol (350 mg iodine/mL; Guerbet).

Embolization technique

Embolizations were performed by five interventional radiologists with 3–20 years of experience. Arterial access was obtained via the right common femoral artery. Proximal embolization was defined as embolization of the main trunk of splenic artery, proximal to its dividing branches but distal to the dorsal pancreatic artery (Fig. 1). Proximal embolization was performed using either 0.035-inch coils or Amplatzer plugs (St Jude Medical) when the anatomy was favorable. Distal embolization was defined as embolization of the terminal branches of the splenic artery with 0.018 inch micro-coils absorbable gelatin material or surgical glue (Fig. 2). Combined embolization was the association of the two techniques. The embolization technique was left to the operator's discretion.

Data collection

All imaging exams were archived in a picture archiving and communication system and were reviewed. The medical data were collected from the patients' computerized medical files. Population characteristics included age, circumstances of the injury, hemodynamic status, simplified acute physiology score 2 (SAPS2), injury severity score (ISS), splenic AAST grade injury (18), splenic

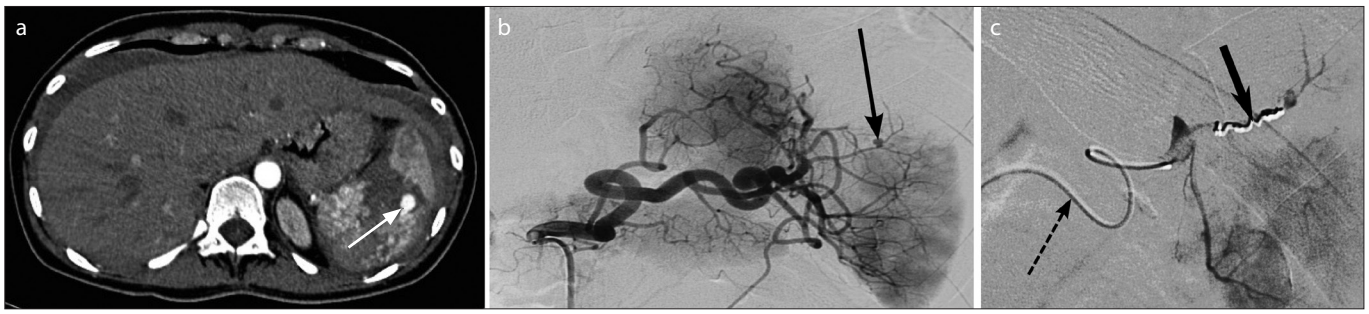

Figure 2. a–c. Distal embolization of a pseudoaneurysm. Transverse contrast-enhanced CT scan of the spleen at an arterial phase **(a)**, shows a pseudoaneurysm *(arrow)* and a contusion of the superior pole of the spleen. Diagnostic arteriography of the splenic artery **(b)** confirms the intrasplenic pseudoaneurysm *(arrow)*. Repeat arteriography with a microcatheter (*dashed arrow*, **c**) after distal embolization with a micro-coil *(thick black arrow)* of the parent artery.

vascular lesion (contrast extravasation, pseudoaneurysm, arteriovenous fistula), large hemoperitoneum (1, 19–21), associated trauma lesions, and length of hospital stay. ISS is an anatomical scoring system for patients with multiple injuries. It takes value from 0 to 75 and corresponds to the sum of the squared scores of the three most severely injured body regions. SAPS2 is a disease severity scoring system for patients admitted to intensive care units. It takes value from 0 to 163 and corresponds to data collected during the first 24 hours (e.g., age, chronic diseases, Glasgow coma score, systolic blood pressure, heart rate, body temperature, serum sodium and potassium levels).

To collect the events occurring during the hospital stay or the follow-up, a binary method was used: death, secondary hemorrhage (requiring any treatment), abdominal compartment syndrome requiring surgery, infectious complication (septic syndrome, abdominal or splenic collection treated with antibiotics and/or drainage, documented pneumonia), pleural drainage, acute respiratory distress syndrome (ARDS), acute renal failure, deep venous thrombosis, splenic pseudocyst (22, 23), total or near-total infarct of the spleen, pancreatitis with serum lipase levels greater than five times the normal level (24), migration of embolization material, or development of secondary splenic vascular lesion. The patients were followed up with at least one CT examination before being discharged.

Statistical analysis

The data were analyzed using Stata/IC 12.1 software under Mac OS X. Baseline patient characteristics were reported as medians and interquartile ranges (IQR; i.e., 25th and 75th percentiles) for continuous variables and percentages for categorical variables.

Demographic data of NOM, SAE, and OM patients were compared using Kruskal-Wallis test for continuous variables and the chi-square test for categorical variables. When the expected number in any cell was less than five, the Fisher exact test was used for two-by-two tables and the Freeman-Halton extension test was used for two-by-three tables.

For each complication, univariate and multivariate analyses were performed with logistic regression analysis adjusting for population characteristics, spleen trauma management, and associated injuries, to search for risk factors for the different adverse events. A total of 23 prognostic factors were investigated: age, SAPS 2, ISS, hemodynamic stability, red cell transfusion prior to admission, AAST grade, large hemoperitoneum, vascular injury, each type of BSI management (OM, NOM, and SAE), each associated injury (encephalic, aortic, cardiac, thoracic, diaphragmatic, renal, hepatic, pancreatic, or intestinal injuries, spinal, pelvic, or limb fractures). The adjusted odds ratio and 95% confidence interval were calculated for each risk factor. The significance threshold was set at $P < 0.05$.

Table 1. Population characteristics

	All patients (n=136)	NOM (n=61)	SAE (n=50)	OM (n=25)	*P*
Age (years), median (IQR)	25 (20–42)	25 (19–39)	26 (19–43)	26 (23–57)	0.519
Spleen injury					
AAST Grade ≥3, n (%)	77 (56.62)	20 (32.79)	42 (84.0)	15 (60.0)	<0.001
Vascular injury, n (%)	58 (42.64)	4 (6.56)	42 (84.0)	12 (48.0)	<0.001
Large hemoperitoneum, n (%)	54 (39.71)	14 (23.0)	23 (46.0)	17 (68.0)	<0.001
Global trauma					
ISS, median (IQR)	25 (16–34)	16 (14.5–24)	20 (16–25)	37 (28.5–43)	0.001
SAPS2, median (IQR)	21 (13.5–34.5)	18.5 (11.5–30)	16 (11–24)	40 (36–50.5)	<0.001
Associated injuries, n (%)	93 (68.38)	36 (59.02)	35 (70.0)	22 (88.0)	0.03
RBCT prior to admission, n (%)	34 (25.0)	0 (0.0)	11 (22.0)	23 (92.0)	<0.001
Length of stay (days), median (IQR)					
Total hospitalization	12 (9–19)	10 (8–14)	14 (11–19)	15 (10–21.5)	0.001
ICU	2 (0–4)	1 (0–3)	2 (1–3)	2 (1.5–11)	0.01

NOM, nonoperative management; SAE, nonoperative management with splenic artery embolization; OM, operative management; IQR, interquartile range (i.e., 25th and 75th percentiles); AAST, American Association for the Surgery of Trauma; ISS, injury severity score; SAPS2, simplified acute physiology score 2; RBCT, red blood cell transfusion; ICU, intensive care unit.

Results

The medical records of 136 consecutive patients with BSI were reviewed (Table 1). Eight patients in OM group did not get a CT scan prior to their surgery due to the urgency of the operation.

The median age of the population was 25 years (IQR, 20–42 years), median SAPS2 was 21 (IQR, 13.5–34.5) and 56.6% of patients were AAST grade ≥3. The median ISS was

Table 2. Post-traumatic injuries

	All patients (n=136)	NOM (n=61)	SAE (n=50)	OM (n=25)	*P*
Brain injury on CT	17 (12.5)	4 (6.6)	5 (10.0)	8 (32.0)	0.009[a]
Spine fracture	10 (7.4)	5 (8.2)	1 (2.0)	4 (16.0)	0.082[a]
Pelvic fracture	21 (15.4)	7 (11.5)	7 (14.0)	7 (28.0)	0.159[a]
Limb fracture	40 (29.4)	13 (21.3)	13 (26.0)	14 (56.0)	0.005
Aortic injury	3 (2.2)	0 (0.0)	3 (6.0)	0 (0.0)	0.135[a]
Cardiac injury	10 (7.4)	5 (8.2)	1 (2.0)	4 (16.0)	0.082[a]
Left thoracic injury (lung, ribs)	75 (55.2)	29 (47.5)	25 (50.0)	21 (84.0)	0.006
Right thoracic injury (lung, ribs)	28 (20.6)	10 (16.4)	11 (22.0)	7 (28.0)	0.459
Diaphragmatic injury	2 (1.5)	0 (0.0)	0 (0.0)	2 (8.0)	0.033[a]
Kidney injury	24 (17.6)	9 (14.8)	9 (18.0)	6 (24.0)	0.533[a]
Liver injury	11 (8.1)	4 (6.6)	2 (4.0)	5 (2.0)	0.055[a]
Pancreatic injury	6 (4.4)	2 (3.3)	0 (0.0)	4 (16.0)	0.008[a]
Hollow viscus injury	9 (6.6)	2 (3.3)	1 (2.0)	6 (24.0)	0.002[a]
Patient with ≥1 injury	93 (68.4)	36 (59.0)	35 (70.0)	22 (88.0)	0.03

Data are presented as n (%).
NOM, nonoperative management; SAE, nonoperative management with splenic artery embolization; OM, operative management; CT, computed tomography.
[a]Freeman-Halton extension test.

Table 3. Clinical outcomes

	All patients (n=136)	Mean delay prior to event (days)	NOM (n=61)	SAE (n=50)	OM (n=25)	*P*
Mortality	4 (2.94)	2.25	0 (0.0)	0 (0.0)	4 (16.0)	0.001[a]
Secondary bleeding	26 (19.12)	3.38	13 (21.31)	6 (12.0)	7 (28.0)	0.195[a]
Splenectomy	10 (7.35)	3.22	6 (9.83)	4 (8.0)	NA	0.503[b]
ACS	8 (5.88)	3.37	2 (3.28)	4 (8.0)	2 (8.0)	0.554[a]
Total or near total splenic infarction	2 (1.47)	115	0 (0.0)	2 (4.0)	NA	0.201[b]
Infectious complication	35 (25.74)	11.97	12 (19.67)	10 (20.0)	13 (52.0)	0.004
Pleural effusion requiring drainage	49 (36.03)	2.2	13 (21.31)	17 (34.0)	19 (76.0)	<0.001
Left	37 (27.21)	2.27	9 (14.75)	14 (28.0)	14 (56.0)	<0.001
Right	12 (8.82)	2	4 (6.56)	3 (6.0)	5 (20.0)	0.132[a]
ARDS	6 (4.41)	5.83	2 (3.28)	2 (4.0)	2 (8.0)	0.656[a]
Acute renal failure	3 (2.21)	0	0 (0.0)	0 (0.0)	3 (12.0)	0.006[a]
Pancreatitis	6 (4.41)	2.86	1 (1.64)	1 (2.0)	4 (16.0)	0.013[a]
Vascular thrombosis	11 (8.09)	11.1	3 (4.92)	4 (8.0)	4 (16.0)	0.265[a]
Splenic secondary vascular lesion	4 (2.94)	4.5	0 (0.0)	4 (6.0)	NA	0.038[b]
Pseudoaneurysm	2 (1.47)	4.5	0 (0.0)	2 (4.0)	NA	0.2[b]
Fistula	2 (1.47)	4.5	0 (0.0)	2 (4.0)	NA	0.2[b]
Splenic pseudocyst	11 (8.09)	28	0 (0.0)	11 (22.0)	NA	<0.001[b]
At least one adverse event	75 (55.15)		20 (32.79)	31 (62.0)	24 (96.0)	<0.001

Data are presented as n (%) unless otherwise noted.
NOM, nonoperative management; SAE, nonoperative management with splenic artery embolization; OM, operative management; NA, data not available; ACS, abdominal compartment syndrome; ARDS, acute respiratory distress syndrome.
[a]Freeman-Halton extension test.
[b] Fisher exact probability test.

25 (IQR, 16–34) but 33.8% of patients had no ISS evaluation. The predominant mechanisms of injury were sports injuries (46.3%), mainly skiing accident, followed by motor vehicle collisions (33.8%).

NOM was the most frequently used management method (44.8%). These were patients with the least severe spleen involvement (32.8% of patient with an AAST grade ≥3, $P < 0.001$) and less severe injury (median ISS: 16, $P = 0.001$; median SAPS2: 18.5, $P < 0.001$). Patients in the SAE group (36.76%) had trauma severity equal to those in the NOM group (median SAPS2, 18.5 for NOM; 16 for SAE) but more severe spleen injury (AAST grade ≥3 in 32.6% of NOM patients vs. 80% of SAE patients) and more frequently a large hemoperitoneum.

In total, 68.4% had at least one other organ injury including 57.4% with an associated thoracic injury (Table 2). Three patients presented with aortic injury: one was a rupture of the aortic isthmus treated by emergency stent-grafting, two were traumatic intramural hematomas that resolved spontaneously.

The survival rate was 97.1% with only four deaths, all in the OM group ($P < 0.001$). One death occurred because of refractory cardiorespiratory arrest at initial management and three due to brain injury (two at day 1 and one at day 7).

NOM and SAE showed 91% effectiveness in terms of spleen salvage with no significant difference between the two groups. In the SAE group, patients underwent proximal (n=18), distal (n=22) and combined (n=8) embolizations without statistical difference between the techniques. There was one catheterization failure and one splenic angiography without embolization (spontaneous hemostasis).

Twenty-six patients presented secondary bleeding. Thirteen were treated with transfusion alone (four in OM, seven in NOM, two in SAE). Thirteen required surgical revisions: three in OM, eight splenectomies (six in NOM, two in SAE), one splenorrhaphy (SAE), and one partial splenectomy (SAE).

The median length of stay in the hospital was 12 days (IQR, 9–19 days) with a significantly shorter stay for NOM patients ($P = 0.001$). OM patients spent more time in the intensive care unit (ICU) ($P = 0.011$).

Patient management was complicated by at least one adverse event in 55.2% of the cases (Table 3): 32.8% of patients in the NOM group, 62% in the SAE group, and 96% in the OM group ($P < 0.001$). Twenty-four

Table 4. Identified prognostic factors for adverse event

Adverse event	Prognostic factor	Crude OR (95% CI)	*P*	Adjusted OR* (95% CI)	*P*
Secondary bleeding	SAPS2 ≥25	10.78 (4.09–28.38)	<0.001	15.81 (5.12–48.86)	<0.001
	Limb fracture	3.77 (1.55–9.16)	0.003	3.58 (1.42–8.98)	0.007
Infectious complication	SAPS2 ≥25	11.17 (4.09–30.5)	<0.001	6.06 (1.93–18.98)	0.002
	NOM	0.34 (0.13–0.93)	0.036	0.76 (0.12–4.91)	0.77
Pleural effusion requiring drainage	SAPS2 ≥25	4.95 (2.19–11.22)	<0.001	3.85 (1.65–9.01)	0.002
	Right thoracic injury	9.29 (3.66–23.54)	<0.001	10.83 (3.83–30.62)	<0.001
	NOM	0.31(0.14–0.71)	0.005	7.68(0.78–75.48)	0.08
ARDS	Age ≥50 years	29.21 (3.23–264.02)	0.003	17.34 (1.8–167.3)	0.014
	SAPS2 ≥25	15.31 (1.72–135.97)	0.014	7.68 (0.78–75.48)	0.08
Pancreatitis	SAPS2 ≥25	15.31 (1.72–135.97)	0.014	11.25 (1.23–103.23)	0.032
	Pancreatic injury	15.75 (2.2–112.68)	0.006	19.04 (0.46–787.31)	0.121
Splenic pseudocyst	Patient with at least one associated injury	7.15 (0.89–57.6)	0.065	27.86 (2.81–275.86)	0.004
	SAPS2 ≥25	4.9 (1.41–16.96)	0.012	5.01 (0.86–29.18)	0.073
Patient with at least one adverse event	SAPS2 ≥25	55.38 (7.29–420.63)	<0.001	28.18 (3.63–223.04)	0.018
	Right thoracic injury	15.65 (3.54–69.26)	<0.001	8.1 (1.8–37.2)	0.02
	Age ≥50 years	3.8 (1.33–10.89)	0.013	2.35 (0.01–708.15)	0.836
	NOM	0.18 (0.12–0.37)	<0.001	0.19 (0.02–1.39)	0.101
Intensive care unit stay, ≥5 days	Spine fracture	18.54 (3.68–93.39)	<0.001	20.79 (2.84–142.45)	0.02
	Right thoracic injury	11.26 (4.25–29.26)	<0.001	9.85 (3.02–31.97)	0.01
	SAPS2 ≥25	13.12 (5.1–33.76)	<0.001	8.3 (2.86–24.02)	0.011

OR, odds ratio; CI, confidence interval; SAPS2, simplified acute physiology score 2; NOM, nonoperative management; ARDS, acute respiratory distress syndrome.
*Univariate and multivariate logistic regression adjusted for population characteristics, splenic injury management (OM, NOM, or SAE) and associated injuries.

patients were lost to follow-up after hospitalization. The median duration of follow-up was nine days (IQR, 5–30 days); follow-up was performed by CT in 67% and US in 33%.

In univariate analysis, OM was associated with significantly more death, infectious complications, pleural drainage, acute renal failure, and pancreatitis during hospitalization. SAE was associated with more pseudocysts, which were diagnosed on average one month after the trauma. Distinguishing pseudocysts from hematomas was difficult at the early follow-up. Only one was symptomatic, requiring secondary splenectomy 240 days later. Secondary bleeding, abdominal compartment syndrome, and ARDS showed no significant differences between the three groups. Splenic infarction and secondary vascular lesions of the spleen showed no significant differences between NOM and SAE.

Six of 23 prognostic factors were statistically significant for one or more adverse events: SAPS2 ≥25, age ≥50 years, spine fracture, right thoracic injury, limb fracture, and having at least one associated injury (Table 4). The management methods (OM, NOM, or SAE) were not a risk factor for any adverse event in the multivariate analysis.

SAPS2 ≥25 was an independent prognostic factor, all groups combined, for a large number of complications. Age ≥50 years was a prognostic factor for ARDS. Associated traumatic lesion was an independent risk factor for certain complications such as limb fracture for secondary bleeding. Right thoracic injury was a risk factor for pleural drainage, for the onset of at least one adverse event and for ICU length of stay ≥5 days.

SAPS2 ≥25 and spine fractures were also independent risk factors for hospitalization in ICU lasting more than five days.

Discussion

With 81.6% of patients treated nonoperatively, including 45% of patients who underwent SAE, our clinical practice is well within the current AAST guidelines (5). Only 9.8% of patients in NOM and 8% in SAE, had a secondary splenectomy despite a high median ISS at 18.5 and the absence of a clearly defined protocol. This could argue in favor of SAE which seems to be more effective in cases of high-grade spleen injury, large hemoperitoneum, or associated vascular lesions (2, 6–10).

The vast majority of studies comparing surgical and nonsurgical BSI management methods describe more infectious complications in OM (25–27), whereas others found a higher sepsis rate after SAE: 12% versus 5%, respectively, in the Duchesne et al. study (28). Splenectomy has even been found as a risk factor independent of sepsis outcome in the study reported by Demetriades et al. (27). We also found more infectious complications in OM in the univariate analysis, but multivariate analysis clearly showed that severity of injury is the true prognostic factor with a SAPS2 ≥25. We chose 25 as a cutoff value because it was the mean SAPS2 of the study patients and the most significant value in the subgroup analysis.

Indeed, in the literature assessing BSI management, some authors consider any adverse event occurring during hospitalization as a complication of this treatment

without any prior statistical relation being proven (11–13, 28). Thus, we have preferred to define the adverse events as any event complicating patient progression, reserving the term "complication" for events that could unambiguously be attributed to the injury or the treatment itself through a statistically significant relationship.

In the Ekeh et al. studies (11, 12), pleural effusion is reported as a complication of embolization in 17%–27% of cases. In the present study, the pleural effusion rate is independent of the management method but directly related to the severity of injury, notably to associated thoracic injury. Duchesne et al. (28) reported a 22% ARDS rate for embolization versus 5% for surgery. This rate was higher in our series for patients in the OM group, but without reaching statistical significance. Pancreatitis, one of the potential complications of embolization (29), was not found to be a significant complication in this group. It was found to be statistically significant in OM, but multivariate analysis showed that it was actually related to the severity of the injury.

Pseudocysts, infrequently described in adults (12, 30, 31), were found in 8.1% of patients and were significantly related to embolization in the univariate analysis ($P < 0.001$). Multivariate analysis showed that associated injuries were the prognostic factor for pseudocyst development. This result is in line with pediatric studies in which pseudocysts are well known to evolve from high-grade injuries treated without embolization (32, 33). However, it may well be in part secondary to the splenic ischemia caused by the embolization (34), even though the low statistical power of this study was not able to demonstrate this.

Detailing polytrauma in OM, Malangoni et al. (15) demonstrated that patients with associated pancreas, colon, central nervous system lesions or limb fracture had a higher risk of sepsis. Patients with an isolated spleen lesion, on the other hand, had a lower risk (15). Similarly, we demonstrated that associated traumatic lesions, such as limb fractures, were independent risk factors for certain complications independently of the type of management, in predicting the risk of secondary bleeding.

The main limitations of this study are its retrospective design and the absence of a written protocol. Patients in OM were significantly very different from the others, with much more severe trauma and more adverse events. It is thus difficult to compare them with those in NOM. However, our aim was to determine the link between adverse events and BSI management and the statistical analysis demonstrated that they were related to the polytrauma severity in all groups. We used the SAPS2, frequently used in Europe and showing performance as good as the ISS in assessing polytrauma patients (35). These two scores, reflecting the severity of polytrauma, were strongly related to adverse event occurrence but we had many missing ISS scores, limiting the statistical analysis of this parameter. Similarly, high AAST grade was not demonstrated as being related to adverse events, which may be due to missing data in patients immediately treated with OM.

In conclusion, 55% of patients with spleen injury present at least one adverse event during their recovery. This rate reaches 96% in operated patients. Statistical analysis shows that this rate is not related to the type of management and that there are no statistically significant complications of any particular treatment. These complications are for the most part related to the severity of the injury and presence of associated lesions.

Conflict of interest disclosure

The author declared no conflicts of interest.

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