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Failure rates of nonoperative management of low-grade splenic injuries with active extravasation: an Eastern Association for the Surgery of Trauma multicenter study

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ABSTRACT

Objectives There is little evidence guiding the management of grade I–II traumatic splenic injuries with contrast blush (CB). We aimed to analyze the failure rate of nonoperative management (NOM) of grade I–II splenic injuries with CB in hemodynamically stable patients.

Methods A multicenter, retrospective cohort study examining all grade I–II splenic injuries with CB was performed at 21 institutions from January 1, 2014, to October 31, 2019. Patients >18 years old with grade I or II splenic injury due to blunt trauma with CB on CT were included. The primary outcome was the failure of NOM requiring angioembolization/operation. We determined the failure rate of NOM for grade I versus grade II splenic injuries. We then performed bivariate comparisons of patients who failed NOM with those who did not.

Results A total of 145 patients were included. Median Injury Severity Score was 17. The combined rate of failure for grade I–II injuries was 20.0%. There was no statistical difference in failure of NOM between grade I and II injuries with CB (18.2% vs 21.1%, $p>0.05$). Patients who failed NOM had an increased median hospital length of stay ($p=0.024$) and increased need for blood transfusion ($p=0.004$) and massive transfusion ($p=0.030$). Five patients (3.4%) died and 96 (66.2%) were discharged home, with no differences between those who failed and those who did not fail NOM (both $p>0.05$).

Conclusion NOM of grade I–II splenic injuries with CB fails in 20% of patients.

Level of evidence IV.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The 2012 Eastern Association for the Surgery of Trauma (EAST) Practice Management Guidelines recommends nonoperative management (NOM) as the preferred treatment in hemodynamically stable patients regardless of injury grade. The management is less clear when there is an active arterial bleed.

WHAT THIS STUDY ADDS

⇒ In this study, we report that NOM of grade I–II splenic injuries with contrast blush (CB) fails in 20% of patients.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our findings suggest that all grade I–II splenic lacerations that were normotensive on arrival to the emergency department with CB could be seen as more similar in course to a grade III injury.

INTRODUCTION

In recent decades, the clinical management of splenic injuries has transitioned from immediate operative intervention to watchful waiting and a minimally invasive approach with angioembolization for hemodynamically stable patients.[1–7] The 2012 Eastern Association for the Surgery of Trauma (EAST) Practice Management Guidelines recommend nonoperative management (NOM) as the preferred treatment in hemodynamically stable patients regardless of injury grade.[8]

The management is less clear, however, when there is an active arterial bleed, described as active extravasation or contrast blush (CB), on a CT scan.[9–11] While evaluating all patients who present with CB, prior studies have demonstrated that splenic injuries with CB increase the risk of splenectomy,[12 13] in some studies by 20-fold.[14] However, very few studies evaluate the risk of failure of NOM in patients with low-grade splenic injuries (grade I–II) with CB, with some asserting that low-grade splenic injuries with CB require no intervention.[15 16]

In contrast, the most recent American Association for the Surgery of Trauma (AAST) 2018 guidelines now suggest treating prior grade I/II splenic lacerations with a CB as grade IV injuries. However, there is little evidence in the literature to support this recommendation due to the low numbers included in prior studies. Furthermore, angioembolization of these injuries could lead to patients undergoing an unnecessary procedure with inherent risks such a splenic infarction, abscess, arterial access injury, contrast nephropathy, coil migration[17] as well as an increased risk of venous thromboembolism[18] and postsplenectomy sepsis.[19]

To date, there have been no large-scale studies to evaluate the failure of NOM for traumatic grade I–II splenic injuries with CB on a CT scan. Therefore, this multicenter study aimed to analyze the frequency of failure of NOM (defined as nonangiographic or surgical intervention) of grade I–II splenic injuries with CB in hemodynamically stable patients.

METHODS

This is a retrospective cohort study of 21 institutions from January 1, 2014, to October 31, 2019. Centers were enrolled through the EAST website. Study data were collected and managed using a centralized Research Electronic Data Capture electronic data capture tool hosted at the lead center.[20 21] A standard data dictionary was developed and used by all sites to ensure use of the same nomenclature based on Trauma Quality Improvement Program (TQIP) definitions.

Inclusion criteria were patients 18 years of age or older with an AAST grade I or II splenic injury secondary to blunt trauma with CB on a CT scan. All mechanisms of blunt trauma were included. Patients were excluded for hemodynamic instability, known bleeding disorders, or medication-induced coagulopathy, including antiplatelet therapy. We excluded patients who were taking warfarin, rivaroxaban, apixaban, dabigatran, clopidogrel, and ticagrelor. Patients on aspirin were not excluded in this study. Hemodynamic instability was defined as a systolic blood pressure (SBP) less than 90 mm Hg within 1 hour of arrival to the emergency department (ED). The primary outcome was failure of medical management requiring angioembolization or surgical intervention resulting in splenectomy. Medical management was defined as hospital admission without planned operative or angiographic intervention. Secondary outcomes included mortality, length of stay (LOS), intensive care unit (ICU) LOS, and need for blood transfusion. Data collection included demographics such as age, sex, mechanism of injury, comorbidities, transfer data, admission SBP, highest SBP within 1 hour on arrival to ED, amount of fluid (all volumes, including crystalloid, blood, blood products) in milliliters received within 1 hour of arrival, location of blush (outside spleen, within the spleen, or outside and within the spleen), need for blood transfusion and massive transfusion, splenic injury grade, and outcome data such as discharge disposition and death (table 1).

Patients who failed NOM were compared with patients who were successfully managed nonoperatively. Statistical analysis was performed, with continuous variables reported as median and IQR. Discrete variables were reported as N (%). P values <0.05 were considered indicative of statistical significance. Continuous variables were analyzed using the Wilcoxon rank-sum test and discrete variables were analyzed using Fisher's exact test. Direct standardization was used to calculate the failure rate of NOM, adjusting for center-specific rates and volumes. All analyses are performed using SAS Enterprise Guide 8.3 statistical software (SAS Institute).

Table 1 Demographic and clinical characteristics by requirement for intervention

Required operative splenectomy or embolization			
Characteristic	**No**	**Yes**	**P value**
Number of patients	116	29	–
Age: median (IQR)	46 (29–61)	50 (31–60)	0.607
Gender: no (%)			
Female	40 (34.5)	10 (34.5)	1.000
Male	76 (65.5)	19 (65.5)	
BMI category: no (%)			
<25.0	42 (36.2)	7 (24.1)	0.047
25.0 to 29.9	41 (35.3)	11 (37.9)	
30.0 to 34.9	13 (11.2)	9 (31.0)	
≥35.0	20 (17.2)	2 (6.9)	
ISS: median (IQR)	17 (12–24)	17 (12–22)	0.749
Transferred from outside facility: no (%)	22 (19.0)	4 (13.8)	0.600
Admission SBP median (IQR)	129 (110–142)	121 (112–141)	0.664
Highest SBP within 1 hour of admit: median (IQR)	140 (125–161)	131 (118–160)	0.169
Splenic injury grade: no (%)			
Grade I	45 (38.8)	10 (34.5)	0.831
Grade II	71 (61.2)	19 (65.5)	
Comorbidities: no (%)			
Current smoker	42 (36.2)	9 (31.0)	0.669
Hypertension	31 (26.7)	10 (34.5)	0.490
Diabetes	11 (9.5)	5 (17.2)	0.316
Alcohol use disorder	19 (16.4)	4 (13.8)	1.000
Substance abuse	15 (12.9)	5 (17.2)	0.553
COPD	4 (3.5)	1 (3.5)	1.000
CHF	1 (0.9)	1 (3.5)	0.361
MI	2 (1.7)	1 (3.5)	0.491
PAD	1 (0.9)	2 (6.9)	0.102

Data are presented as absolute number with percentage in parentheses.
CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; ISS, Injury Severity Score; MI, myocardial infarction; PAD, peripheral artery disease; SBP, systolic blood pressure.

RESULTS

There wasere a total of 209 patients from 21 institutions enrolled in this study. Of these, 64 (30.6%) patients were excluded from the study: 44 due to no documentation of CT evidence of CB, 9 due to hemodynamic instability at admission, 9 patients who underwent a prophylactic/planned intervention, and 2 patients who underwent exploratory laparotomy for other injuries. Thus, 145 patients were analyzed in the study (figure 1), which was comprised of 65 (66%) men and a mean study population age of 47 years. The median Injury Severity Score was 17 with motor vehicle collision being the most common mechanism of injury (67%) followed by falls (12.3%). All patients in the study received a CT scan within 24 hours of being admitted. The mean time to admission CT was 48 min (SD 60), and the median time was 30 min (IQR 13–60 min). There were 55 (37.9%) patients with grade I splenic injuries with CB and 90 (62.1%) grade II injuries with CB.

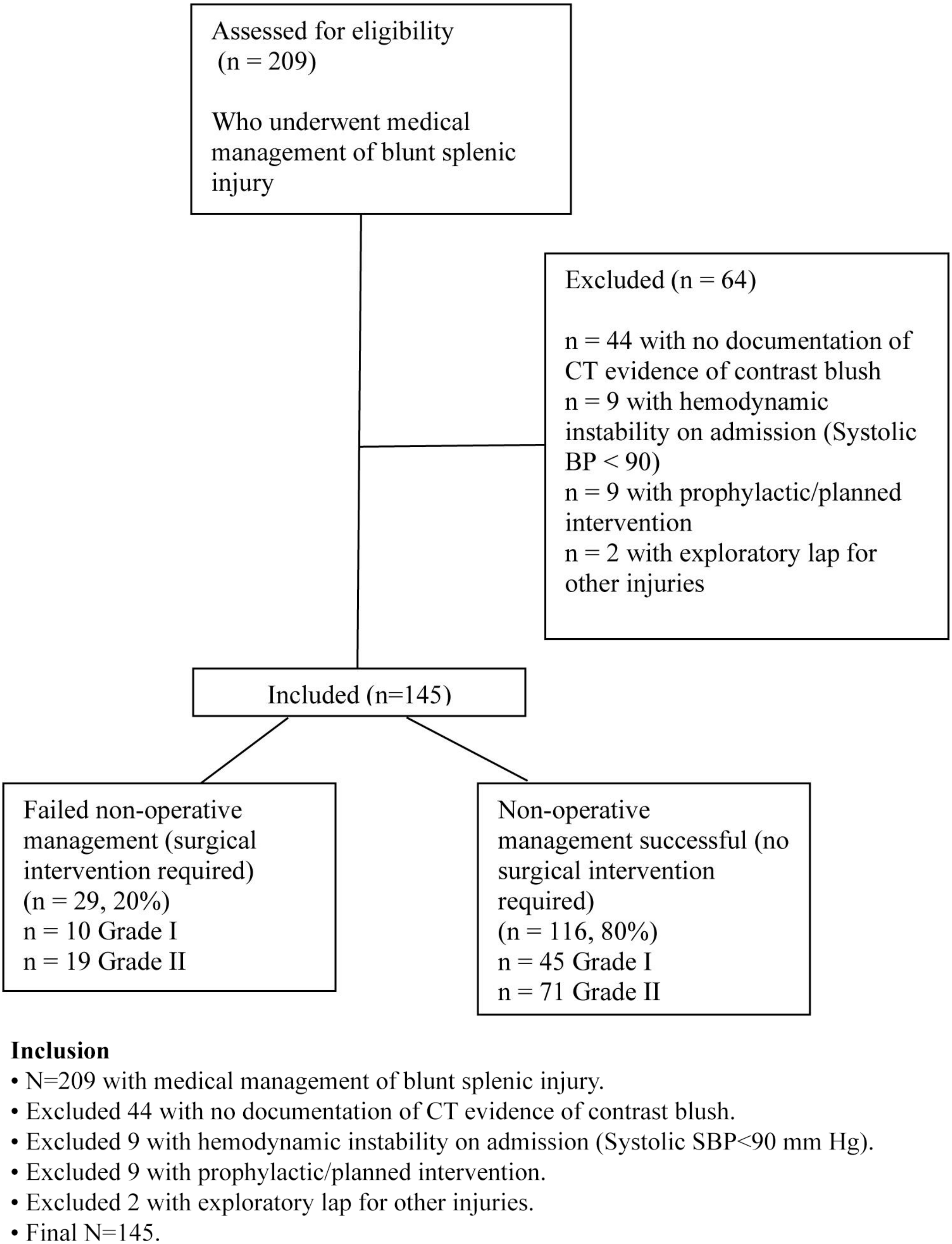

Figure 1 CONSORT diagram.

Table 2 Clinical characteristics and outcomes by requirement for intervention

Required operative splenectomy or embolization			
Characteristics	**No**	**Yes**	**P value**
Number of patients	116	29	–
Contrast blush location: no (%)			
Outside spleen	33 (28.5)	8 (27.6)	0.744
Within spleen	79 (68.1)	19 (65.5)	
Outside and within	4 (3.5)	2 (6.9)	
Amount of fluid (mL) received within			
1 hour of admit: median (IQR)	650 (0–1000)	1000 (0–2000)	0.221
Need for blood transfusion: no (%)	30 (25.9)	16 (55.2)	0.004
Need for massive transfusion: no (%)	3 (2.6)	4 (13.8)	0.030
Hospital LOS days: median (IQR)	5 (3–10)	8 (5–14)	0.024
ICU LOS days: median (IQR)	2 (0–4)	3 (1–5)	0.096
Discharge disposition: no (%)			
Home	77 (66.4)	19 (65.5)	0.678
Skilled nursing or rehabilitation	34 (29.3)	10 (34.5)	
Deceased	5 (4.3)	0 (0)	
Mortality: no (%)	5 (4.3)	0 (0.0)	0.583

Data presented as absolute number with percentage in parentheses.
ICU, intensive care unit; LOS, length of stay.

The combined rate of failure for both grade I and II injuries was 20.0% (29 patients, 20.0%–95% CI=13.8 to 27.4); the standardized rate to adjust for center-specific volumes was 22.1% (95% CI=14.4 to 29.8). There was a statistically similar rate of NOM failure for grade I versus grade II injuries (18.2% vs 21.1%, p=0.831, 95% CI=9.1 to 30.9 and 13.2 to 31.0, respectively). There was also no difference in NOM failure based on the location of the splenic blush (see table 2). Of the 29 patients who failed medical management, 11 (37.9%) required operative splenectomy whereas the remaining 18 were managed with IR embolization (see table 3). There were no patients who underwent angioembolization that then required splenectomy.

Table 3 Intervention details

Intervention characteristics	No (%)
Combined failure rate (grades I and II)	29 (20.0), 95% CI=(13.8 to 27.4)
Failure rate grade I	10 (18.2), 95% CI=(9.1 to 30.9)
Failure rate grade II	19 (21.1), 95% CI = (13.2 to 31.0)
Type of intervention	
Operative splenectomy	11 (37.9)
Splenic embolization	18 (62.1)
Time to intervention (to arriving trauma institution)	
<12 hours	20 (69.0)
12–23 hours	1 (3.4)
24–35 hours	4 (13.8)
36–48 hours	4 (13.8)
Indication for intervention	
Hemodynamic instability	9 (31.0) (4 operative, 5 embolization)
Pseudoaneurysm	8 (27.6) (2 operative, 6 embolization)
Decrease in hemoglobin	4 (13.8) (0 operative, 4 embolization)
Hemoperitoneum	3 (10.3) (3 operative, 0 embolization)
Readmission with abdominal pain	1 (3.4) (0 operative, 1 embolization)
Unknown/ no indication given	4 (13.8) (2 operative, 2 embolization)

Data presented as absolute number with percentage in parentheses. Lower and upper limits of 95% CI presented for nonoperative management failure rates of grades I and II injuries.

Patients who failed NOM versus patients managed successfully with NOM

Patients who failed NOM had an increased hospital LOS (5 days vs 8 days, p=0.024) but statistically similar median ICU LOS (2 days vs 3 days, p=0.096) compared with those who were managed with NOM successfully. Patients who failed NOM more commonly underwent blood transfusion (25.9% of patients vs 55.2% of patients, p=0.004) and massive transfusion (2.6% of patients vs 13.8% of patients, p=0.03). Patients who failed NOM were most likely to require intervention within the first 12 hours of arrival at the hospital (see table 3). There was no difference in discharge disposition or mortality between the two groups (see table 2). In total, 66.2% of patients were discharged home and 30.3% were discharged to a rehabilitation facility or a skilled nursing facility. Four patients who failed NOM required later intervention (36–48 hours). The reasons for these later interventions include increased abdominal pain and interval CT with pseudoaneurysms, hypotension, increased abdominal pain, and suspicion for pseudoaneurysm, pseudoaneurysm, and abdominal pain and CT with redemonstration of extravasation. Patients were usually reimaged due to clinical change, hypotension, or a drop in hemoglobin.

DISCUSSION

Splenic injury is a common solid organ injury after blunt force trauma. However, the management has changed significantly as CT imaging has improved and the field of interventional radiology progresses. Historically, splenectomy was the treatment of choice for splenic lacerations. Sclafani[1] first described the role of angiography in treating blunt splenic trauma in the early 1980s. Although grade I–II injuries are often thought to be mild, when they occur with a CB there is an unclear definition of the severity of these injuries (eg, AAST consideration to make this a grade IV injury) and the management. This large multicenter study found that grade I–II splenic injuries with CB fails in 20% of patients.

CB has been identified as a predictor of NOM failure,[22] and grade of injury correlates with an increased incidence of CB.[23] However, grade I–II splenic injuries with CB are relatively rare. There has been debate regarding the management of low-grade splenic injuries with CB in hemodynamically stable patients. A study by Omert *et al*[24] in 2012 concluded that the presence of CB was not an absolute indication of angioembolization. However, this was a small study at only two institutions and thus may lack generalizability as interventional radiology practices are variable throughout the country. In addition, only 138 patients had grade I–II injuries and only 5 of them had CB (3.2%). Another single institution study in 2013, reported good outcomes with NOM in low-grade injuries with CB, but this was a small population consisting of only 40 patients.[15] This is the largest multicenter study to date evaluating the outcomes of NOM of grade I and II splenic injuries with CB.

Despite a lack of studies describing the natural history of NOM for grade I–II splenic injuries with CB, many authors consider signs of CB as an indication for angioembolization in stable patients. In 2015, Brillantino *et al* prospectively evaluated NOM of both minor (grades I–II) and severe (grades III–V) splenic injuries based on the 2008 AAST grading system. Although they found that NOM was successful in all grades, this study excluded patients with CT-documented vascular injury at admission, as all patients with CB underwent diagnostic angiography and splenic embolization.[25] Recently, Zarzaur *et al*[26] described the natural history of splenic injury and the current management of splenic pseudoaneurysms and CB in 2017 and discovered that active bleeding vascular injuries were associated with a 40.9% risk of splenectomy. Similar to other studies in the literature, they did not delineate the risk of failure of NOM with CB based on injury grade.

The most recent 2018 AAST splenic trauma guidelines have been updated to consider any splenic injury with vascular involvement or active bleeding within the splenic capsule as a grade IV injury.[27] Although there have been two retrospective studies suggesting that the newer 2018 AAST guidelines better predicted the need for operative management than the previous guidelines,[28 29] it is unclear whether the consideration of CB in patients with grade I–II injuries as grade IV injuries improved this prediction. The anticipated failure rates of NOM based on AAST splenic grades are as follows: AAST grades I (4.8%), II (9.5%), III (19.6%), IV (33.3%), and V (75.0%).[3] After ruling out patients who were admitted to the hospital hypotensive, the failure rate of NOM of patients with CB and grade I or II splenic injuries more closely aligned with grade III injuries than grade IV injuries.

Our data indicates that when patients failed NOM of low-grade splenic injuries with CB, patients expectedly had increased hospital LOS and need for blood transfusion but did not increase ICU LOS nor did they have an increase in mortality. Our findings suggest that all grade I–II splenic lacerations that were normotensive on arrival to the ED with CB should be classified as grade III. This downgrade in splenic injury grade will likely decrease splenic embolization in many institutions and its associated complications.

The type and rate of complication of splenic embolization depends on whether the spleen is embolized proximally or distally. In general, patients who undergo splenic embolization more proximally are more susceptible to infection, whereas those who are embolized more distally are more susceptible to infarction. Schnüriger *et al*[30] performed a meta-analysis evaluating the rate of complications of splenic embolization performed proximally and distally. In their study, the patients whose spleens were embolized more proximally, 0.5% of patients developed an infarction that ultimately required splenectomy whereas 1.9% developed infection requiring splenectomy. In patients who underwent distal embolization, 2.7% developed infarction that required splenectomy whereas 0% developed infection that required splenectomy. Many of the patients in the study developed splenic infarction but did not ultimately require splenectomy (5.8% of patients embolized proximally and 18.3% of patients embolized distally). Trauma surgeons must weigh these risks of splenic embolization with the risk of failure of NOM with low-grade splenic injuries with CB.

There are several limitations to this study including those inherent to its multicenter retrospective design. Also, the presence or absence of CB was determined by the attending radiologist report, which may not have been available at the time of injury for the practicing trauma surgeon and was not verified by a blinded panel of expert radiologists for this study. Although CB may be mistaken for pseudoaneurysms or calcifications on some CT imaging, by assuming the best practice of radiologists and trauma surgeons at each participating institution, we think this makes our study more generalizable to the typical trauma center. Additionally, our study did not address the use of anticoagulant therapy in low-grade splenic injuries with CB and we chose to only evaluate patients with no preexisting bleeding diatheses, thus this data is not generalizable to these relatively common populations of trauma patients. Also, it must be reiterated that this data only applies to patients who are hemodynamically normal.

CONCLUSION

NOM of grade I–II splenic injuries with CB fails in 20% of patients.

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