Failure Risk Factor For Non-Operative Treatment of Splenic Trauma

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Research article

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Abstract

Background: Splenic trauma is a common pattern for admission in blunt abdominal trauma. The objective of this study is to identify risk factors for failure of non-operative management (NOM) in splenic trauma.

Methods: This is a retrospective monocentric analysis of a prospectively collected database. All patients admitted in the university hospital of Nice [Centre Hospitalier Universitaire (CHU) de Nice, France] for a splenic trauma from January 1st 2006 to January 6th 2018 were included. Primary outcome was the need for delayed splenectomy as an indicator of NOM failure.

Results: Two-hundred-eighty patients were included in this study. Most splenic lesions were severe grades (grade 3 or higher). In total, 83 splenectomies were performed urgently, i.e. 29% of patients; 88 angio-embolizations, i.e., 31% of patients with a success rate greater than 80%; 14.7% of 136 patients who had no previous angio-embolization required secondary splenectomy; 19.7% of the 61 patients who had anterior angio-embolization required secondary splenectomy. Age was not found associated with a higher failure rate (44 years in successful embolization vs 37.5 years in NOM-failure group, $p = 0.15$). Higher drop in hemoglobin levels between admission and 6 hours after admission was detected in the embolization failure group (-1.44 g/dl) as compared with the successful group (-0.68 g/dl), which approached statistical significance ($p = 0.064$).

Conclusions: Hemoglobin monitoring in the hours following the admission of a patient with splenic trauma might be an important factor during the medical supervision of hemodynamically stable patients. Early identification of patients at high risk of NOM failure by hemoglobin monitoring may prevent late splenectomy.

Level of evidence: IV (retrospective study)

Background

Abdominal trauma is present in 7 to 10% of severely injured patients. In the case of blunt abdominal trauma, 45% have a splenic lesion, making it the most frequently injured organ in blunt abdominal trauma (1).

CT-scan is the reference imaging exam for trauma patients whose hemodynamic status is considered stable or responds to vascular filling (2, 3). CT-scan can identify splenic lesions, provide a morphological description according to the AAST classification (American Association for the Surgery of Trauma) (4), but the scanner is not the only parameter to consider when choosing the best treatment for trauma patients.

The gold-standard treatment for patients with splenic injury in blunt abdominal trauma with stable hemodynamic status is the non-operative management (NOM), which is performed in approximately 80%

of patients (5, 6). This medical management is effective in 62 to 92% of cases, likely because of the increasingly frequent use of splenic angioembolization (5, 7–10). It is difficult to identify patients who will have NOM failure and require secondary splenectomy (5, 6, 11–14). Many risk factors for NOM failure have been proposed, but none can accurately predict the failure of NOM.

This study aims to find parameters to predict NOM-failure in case of blunt abdominal trauma with a splenic lesion, which will help in selecting patients in whom splenectomy first intention would be indicated.

Methods

This a retrospective monocentric study of a prospectively collected database. All patients admitted in the university hospital of Nice (Centre Hospitalier Universitaire (CHU) de Nice, France) for a splenic trauma from January 1st 2006 to January 6th 2018 were included. Primary outcome was the need for delayed splenectomy in patients treated with NOM as an indicator of NOM failure.

The following data were collected: epidemiological data, gender, circumstances of the accident, hemodynamic status at admission, injury associated with the calculation of ISS score (Injury Severity Score), patient management, length of stay, and possible morbidity and mortality [according to Clavien-Dindo classification (15)].

Abbreviated Injury Scale (AIS) classification was used to classify trauma severity from CT scans of hemodynamically stable patients or according to operative findings.

Biological data were also analyzed, such as hemoglobin (g/dl), arterial pH, and arterial lactates at admission and every 6 hours during the first 36 hours of management.

Hemodynamic stability was defined by heart rate between 50 and 90 beats per minute and systolic blood pressure above 90 mmHg. Permissive hypotension was not a goal at the time of the study.

Patients with extra-abdominal trauma requiring therapeutic procedure other than splenic were included in the splenic NOM group.

Selective distal splenic embolization was proposed in hemodynamically stable patients for whom the CT scan revealed active contrast leakage or splenic pseudoaneurysm. Proximal prophylactic angioembolization was not proposed in this study.

In the case of NOM, abdominopelvic CT-scan with contrast injection at arterial and portal time was routinely performed on the 5th day after the trauma. In the event of discomfort, deglobulization, appearance of abdominal pain, or other clinical signs considered worrying, an emergency CT scan could be performed earlier.

The primary endpoint was NOM failure with secondary splenectomy.

The failure of NOM was considered in the following cases:

- Multiple intrasplenic pseudoaneurysms (> 3) at the control CT scan performed at day 5 after the trauma;
- Illness with hypotension, hemorrhagic shock or massive deglobulization suggestive of a secondary rupture of the spleen and imposing an emergent splenectomy;
- Infection of the previously embolized splenic parenchyma areas: abdominal pain in the left hypochondrium, fever, biological inflammatory syndrome, and signs of infection of the embolized territory with CT injected (intra-parenchymal air bubbles).

This latter situation represents the late failures of NOM, referred to as secondary splenectomy in our study.

The database is approved by the French committee for privacy statements (Commission Informatique et Liberté) and authorized by the University Hospital of Nice. The data is stored on a secure server at Nice University Hospital.

A statistical analysis was performed. Data extraction and descriptive statistics were performed using Stata→ 15.0 software (Stata Corp., College Station, USA).

Univariate analysis was performed looking for NOM failure factors and angioembolization using a t-test.

Results

A total of 280 patients were included in our study. Descriptive data are listed in Table 1. More than 70% of the patients were men, and most of the splenic lesions were severe (grades > 3).

Table 1: descriptive table of categorical variables

Variable	N (%)
Gender	77 (27.5)
-Female	203 (72.5)
-Male	0
Missing data	
Road accident:	197 (70.9)
-Yes	81 (29.1)
-No	2
Missing data	
Hemodynamic instability at admission:	96 (34.3)
-Yes	184 (65.7)
-No	0
Missing data	
Spleen lesion stage:	3 (1.1)
-None	46 (16.4)
-1	52 (18.6)
-2	71 (25.4)
-3	85 (30.4)
-4	23 (8.2)
-5	0
Missing data	
Hepatic lesion stage:	228 (81.4)
-None	13 (4.6)
-1	14 (5.0)
-2	12 (4.3)
-3	13 (4.6)
-4	52 (18.6)
Total	0
Missing data	

Thoracic lesion stage:	104 (37.1)
-None	176 (62.9)
-Present	0
Missing data	
Renal lesion:	61 (22.7)
-Yes	208 77.3)
-No	11
Missing data	
Pelvic lesion:	49 (17.6)
-Yes	230 (82.4)
-No	1
Missing data	
Cerebral lesion:	50 (18.8)
-Yes	216 (81.2)
-No	14
Missing data	
Active bleeding on CT scan:	54 (20.4)
-Yes	211 (79.6)
-No	15
Missing data	
Emergency splenectomy:	83 (29.6)
-Yes	197 (70.4)
-No	0
Missing data	
Delayed splenectomy:	32 (11.4)
-Yes	248 (88.6)
-No	0
Missing data	
Splenic embolization:	88 (31.4)
-Yes	192 (68.6)

-No	0
Missing data	49 (80.3)
Result of splenic embolization:	12 (19.7)
-Success	
-Failure (required splenectomy)	
Deceased:	20 (7.1)
-Yes	260 (92.9)
-No	0
Missing data	9/83 (10.8)
Mortality after emergency splenectomy:	1/32 (3.1)
Mortality after delayed splenectomy:	

During the study, 83 splenectomies were performed urgently, i.e. 29% of patients and 88 angioembolizations i.e., 31% of all patients, with a success rate greater than 80%.

The mortality rate after emergency splenectomy was high, reaching 10%.

Table 2 shows the continuous variables. The median age was 39 years, and the Glasgow Coma Scale was 13 at admission. The ISS score was high, with a median of 28.9. There was no statistically significant difference with ISS score between successful NOM and failure of NOM.

Table 2
Major parameters of various groups of the study. Values are median values. Hb: hemoglobin in g/dl ; lactates in mmol/l ; H0 and H6: hemoglobin level at admission (H0) and 6 hours after admission (H6) ; AIS: Abbreviated Injury Scale; ISS: Injury Severity Score; LOS: length of stay (days) ; NOM: Non-operative management.

	Nb of patients	Age	Abdominal AIS	ISS	Hb H0	Hb H6	lactates H0	lactates H6	LOS
Total	280	35	3	25	12,3	11,9	2,47	2,36	10
Emergent splenectomy	83	34.5	4	38	10,9	11,9	3,155	2,84	12
NOM	197	35	3	20	13,1	12	1,72	1,75	9
NOM with angio-embolisation	88	34	3	20	13,1	11,9	1,81	1,76	9
Success of angio-embolization	66	36	3	20	13,2	11,7	2,48	1,83	12
Delayed splenectomy	32	40.5	4	27	13,6	11,25	3,115	0,92	15

Hemoglobin levels were also monitored during the first 36 hours, ranging from an average of 12 g/dl at entry to 10.8 g/dl at 36 hours.

Some data were missing and could not be included in our study. This mainly concerns biological data, such as pH changes, lactate levels, and changes in hemoglobin. This can be explained by the variability of care depending on the patient's condition and the blood test performed, which is considered repetitive for some.

Figure 1 shows the time when angioembolization was performed in the case of NOM. In 57% of cases, angioembolization was performed on the day of admission, which corresponds to patients presenting with active bleeding or aneurysm and in a stable hemodynamic state. This rate then decreases until we observe a second peak on the 5th day (11% of patients), corresponding to the completion of a control CT-scan.

It can be observed that 28% of splenectomies were performed on the day of the admission, followed by a decrease, with a subsequent increase at D5 and D8 (12.8% of splenectomies). Again, these peaks correspond to the control imaging with the presence of a significant lesion not accessible to angioembolization or deglobulization (Fig. 2).

Embolization was not found as a protective factor for performing secondary splenectomy. A total of 14.7% of the 136 patients (i.e. 20 patients) who did not have primary angioembolization required

secondary splenectomy, and 19.7% of the 61 patients (i.e. 12 patients) who had primary angioembolization required secondary splenectomy (p = 0.382).

There is no statistically significant difference between age and failure of nonoperative management; the median age of the successful embolization group was 44 years vs 37.5 years in the angioembolization failure group (p = 0.15).

The last analysis compared the decrease in hemoglobin between admission (H0) and 6 hours after admission (H6) from management between the angioembolization group and the angioembolization failure group. The hemoglobin differential between H0 and H6 appears to increase in patients with failed angioembolization (Table 3).

Table 3
Hemoglobin variation between admission and 6 hours after admission for patients with non-operative management and angio-embolization.

	Patients	Hemoglobin variation	Standard deviation	CI 95% (p)
Successful NOM due to angio-embolization	66	0.68	1.84	0.06–1.3
NOM Failure despite angio-embolization	12	1.44	1.17	0.59–2.28 (p = 0.064)

The group of patients who had an angioembolization failure had a decrease in hemoglobin level of -1.44 g/dl between H0 and H6 vs. -0.68 g/dl for those who had a successful angioembolization (p = 0.064).

Discussion

NOM is the gold-standard treatment for hemodynamically stable trauma patients and is eligible for 80% of patients (5, 6). Performing a CT scan with different injection times and especially arterial allows a precise morphological assessment and guides the therapeutic strategy. CT enables searches for active bleeding or pseudoaneurysm resulting in angioembolization (5, 7–10). However, NOM can fail in multiple ways, leading to secondary splenectomy (5, 6, 11–14).

Many risk factors for NOM failure have been proposed, but none can accurately predict the failure of NOM.

Grade 3 or higher lesions are more at risk of NOM failure (according to AAST classification) (5, 6, 14, 16, 17). In AAST 4 and 5 splenic lesions, the failure rate of NOM is 54.6% (19).

Arterial blush on CT in the absence of angio-embolization is described as a risk factor of conservative treatment failure (5, 8, 18), as well as diffuse hemoperitoneum (14, 16).

A severe injury associated with a high ISS would be predictive of a higher rate of NOM failure. Different ISS values are reported in the literature as limiting to a NOM [e.g., 15 (9), 25, and others (14, 16, 17)]. Combining a splenic trauma with a brain injury can complicate the surveillance (19).

The importance of age in NOM has been debated. Age greater than 55 years would increase the risk of NOM failure, especially for high-grade lesions (5, 14, 20); age greater than 40 years could be a NOM failure factor, according to other authors (16). In our study, the median age was 39 years. We detected no statistically significant difference for age; nor did we detect a statistically significant difference according to AAST classification, ISS, or mechanism of injury.

Biological abnormalities, such as a decrease in hemoglobin, pH, or an increase in arterial lactates, might be factors for NOM failure. Alcohol consumption is common during trauma and might result in a falsely high value of lactate or prolong lactate clearance; it must, therefore, be taken into account when evaluating patients with a high blood alcohol level (21). The value of lactate and bicarbonates was identified as an important independent predictor of the polytrauma patient with acute alcohol and drug use (22, 23).

In our study, there is a difference in hemoglobin values at H0 and H6 between the groups having failed angioembolization and the successful group of angioembolization. This result, however, remains nuanced since it is, by little, not statistically significant ($p = 0.064$). This result can probably be explained because of the small number of patients. This result is nevertheless interesting since it is understood that biological deglobulization may be the first sign of true bleeding requiring secondary splenectomy.

In the literature, a decreased value of hemoglobin in the hours following the admission of trauma patients has never been described as NOM failure factors. On the other hand, the need for transfusion of red blood cells is a risk factor for NOM failure (16, 18).

In our study, the lack of data can represent a bias. Thus, the study of lactate levels could not be performed; this is explained by the disparity of care and evolution of patients. Indeed, lactate often dosed at H0 was not necessarily dosed in the aftercare. A study addressing the variation of lactatemia as a failure factor of NOM in splenic trauma might be interesting.

In this study, we could not demonstrate that angioembolization prevented secondary splenectomy. However, this is not comparable to the lack of benefit and is likely due to the lack of power of the study.

A multivariate analysis of the different predictors of NOM failure would also be useful. Unfortunately, we could not achieve this because of the amount of missing data. A multicenter prospective study would address these limitations and should now be conducted to confirm the role of deglobulization in the management of patients with splenic trauma.

Conclusion

Surgical emergencies are an important part of the activity of our hospitals. The trauma patient is a key issue because of the acute care required and the choice of the most appropriate treatment. NOM has become the standard for a hemodynamically stable patient, even though it has a significant failure rate. Deglobulization 6 hours after admission could represent a new risk factor for NOM failure. The need to highlight predictive factors of NOM failure in multicenter prospective trials is essential to achieve optimal patient care.

List Of Abbreviations

NOM: non-operative management

CHU: Centre Hospitalier Universitaire (French word for Teachning Hospital)

AAST: American Association for the Surgery of Trauma

AIS: Abbreviated Injury Scale

ISS: Injury Severity Score

Declarations

Consent for publication

Not applicable

Funding

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Ethics approval and consent to participate: this study was approved by the ethical committee of the hospital. The database is declared to French national database services (Commission Nationale Informatique et Liberté)

Availability of data and materials: the datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest: The authors declare that they have no competing interests

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All authors have been actively involved in the conception of this manuscript and approved this version

Author Contribution statement:

- literature search has been done by Dr Tokoto, Dr Maubert and Dr Massalou
- study design and data collection have been done by Dr Massalou,
- data analysis has been done by Dr Douissard
- Data interpretation, writing and critical revision have been done by all the authors,

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Figures

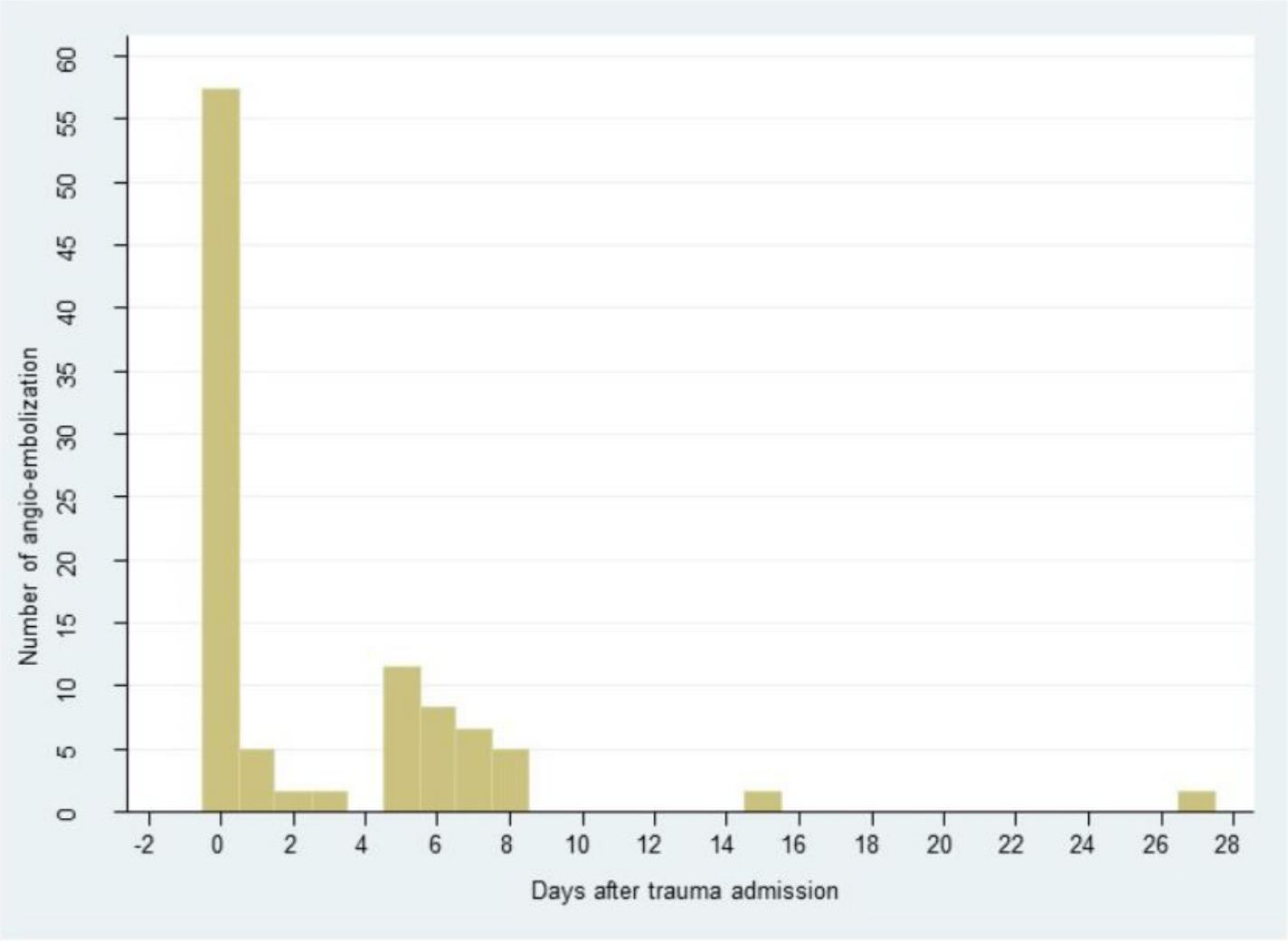

Figure 1

day of angio-embolization during hospital length of stay

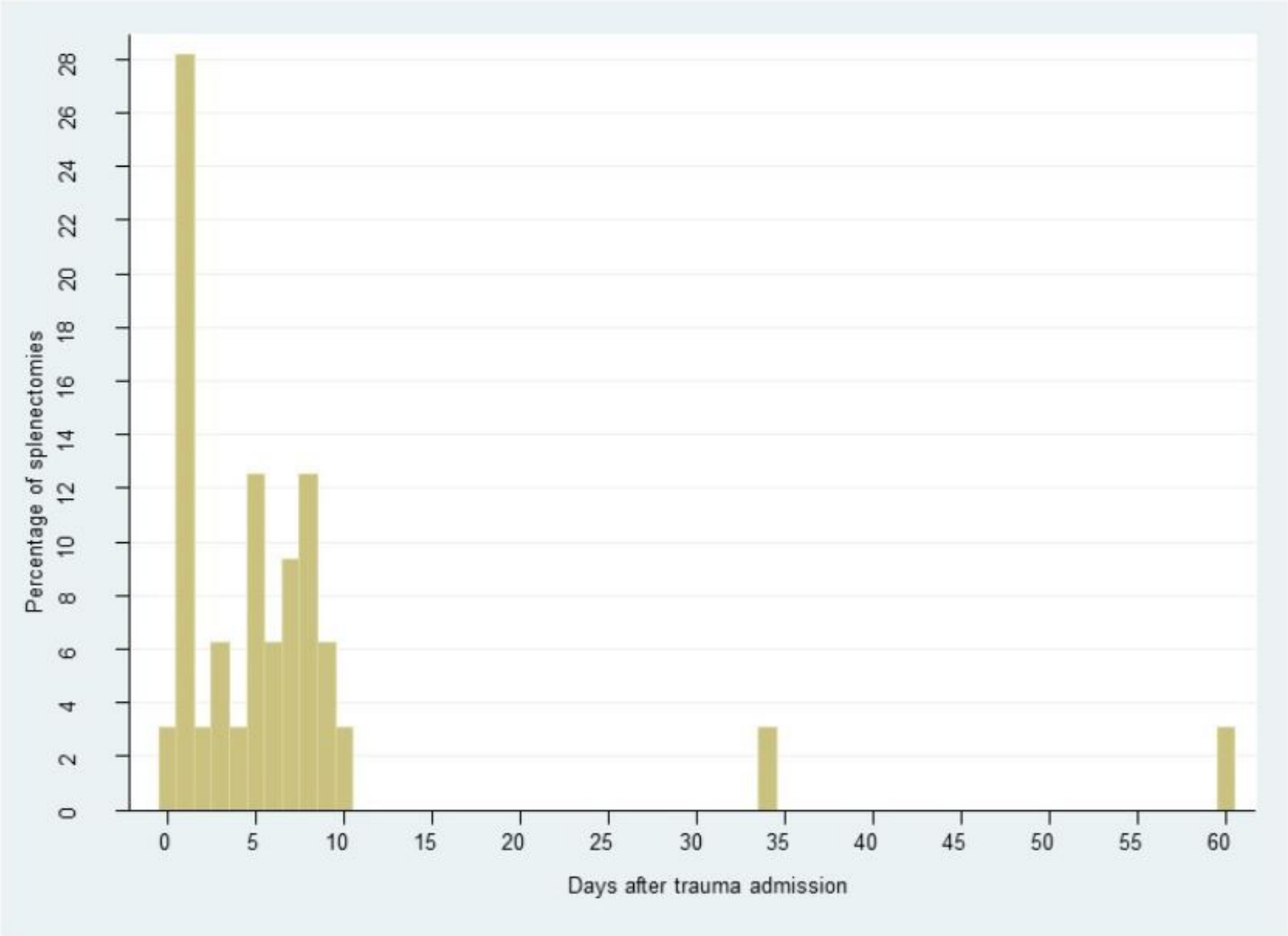

Figure 2

day of splenectomy during hospital length of stay