Back-To-The Traditional: Clinical Judgment Overrides Investigations As Predictors For Success Of Non-Operative Management And Survival Of Blunt Splenic Injury Patients

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Abstract
Objectives: Evaluation of outcomes of the non-operative management (NOM) of patients who had a blunt splenic injury (BSI) and the predictors for such outcome.
Patients & Methods: The study included 95, 68, and 61 patients of grades I, II, and III, respectively, according to the AAST grading of splenic trauma. Patients were evaluated at the intermediate care unit for trauma extent and severity using the New Injury Severity Scale (NISS), consciousness using Glasgow Coma scale, hemodynamic status, and gave blood samples for estimation of hemoglobin concentration (Hb. conc.). Patients who showed deterioration were shifted either to urgent splenectomy or admitted to ICU. The success rate of NOM was defined as control of hemodynamic instability if present, stable splenic injury, the quantity of hemoperitoneum if present with no need for ICU admission for any indication, and survival rate of patients who had succeeded or failed NOM.
Results: During NOM, 29 patients were admitted to ICU, 21 patients underwent urgent splenectomy and two patients deceased. Fifteen of patients admitted to ICU completed their NOM uneventfully and 5 patients underwent elective splenectomy, while 9 patients were deceased. Five of the 26 patients who underwent splenectomy died. The total survival rate was 92.9%; 187 patients completed NOM (94.4%) and 21 had surgery (80.8%) with a significant difference in favor of NOM. Statistical analyses defined high at admission Hb. conc., young age, normal SBP, low NISS score, and low AAST grade were the predictors for NOM success with decreasing order of importance. Kaplan-Meier regression analysis defined SBP at 106 and 104 mmHg as the cutoff points for the probability of NOM success and survival**.**
Conclusion: Proper selection of BSI patients allowed a high success rate (83.5%) and survival rate (94.4%) of NOM. Young aged patients with low NISS scores and high SBP and hemoglobin concentration are the ideal candidate for NOM with suspected high success and survival rates, irrespective of injury grade. High SBP and low NISS scores are the best predictors with high positive predictive value and sensitivity for the success of NOM.

Keywords: *Blunt splenic injury, Non-operative management, splenectomy, the survival rate*

Introduction

The spleen is the most injured solid organ in blunt abdominal trauma, irrespective of the size of the spleen [(1)]. Operative (OM) or non-operative management (NOM) of splenic injury is still a dilemma; hemodynamically unstable patients secondary to splenic trauma need urgent definitive OM as life-saving intervention [(2)].

A high mortality rate after splenectomy secondary to post-operative overwhelming infections was reported by early studies **[(3)]**. Post-splenectomy severe infection was documented to occur not only within two years after surgery, but it may occur even 10 years after splenectomy, and its onset is linked to age and reason for splenectomy [(4)]. More recently, it was documented that overwhelming post-splenectomy infections were associated with a high incidence of mortality [(5)]. Moreover, splenectomy results in significant long-lasting changes in circulating immune cell populations and function [(6)].

These post-splenectomy complications compelled the need for splenic preservation techniques which improve the overall health status of the patients and prevent post-splenectomy complications [(7)]. Accordingly, NOM became the current standard of care in hemodynamically stable patients with blunt splenic injury [(8)]. Moreover, recent trauma guidelines recommend NOM for grade III splenic injury without contrast extravasation on computed tomography [(9)].

Objectives

The current study targets to evaluate the outcomes of the non-operative management (NOM) of patients who had a blunt splenic injury (BSI) and to define the predictors for such outcomes.

Design

Prospective comparative study

Setting

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Patients and Methods

All patients who arrived at the Emergency Department at Benha University Hospital, a referral hospital for traffic accidents, with blunt abdominal trauma from June 2017 till Jan 2021, were eligible for evaluation. The study protocol was approved by the Local Ethical Committee and written consent was obtained by the nearest patient's relative.

All patients were immediately admitted to an intermediate care unit for evaluation of the extent and severity of trauma using the New Injury Severity Scale (NISS; Appendix I.I) and consciousness using the Glasgow Coma Scale (GCS Appendix I.II). Hemodynamic status was evaluated by immediate non-invasive monitoring of blood pressure measures and heart rate (HR). Then, patients were clinically examined according to the traumatized organ and/or region, and blood samples were obtained for estimation of hemoglobin concentration (Hb. conc.), which is monitored 6-hourly and for

other routine laboratory investigations. After immediate resuscitation, patients with abdominal trauma with suspected solid organ injury underwent CT scanning for determination of prerequisite data for splenic injury grading, if present, using the Injury scale for Spleen according to guidelines of the American Association for the Surgery of Trauma Organ (Appendix I.III). The presence and extent of internal bleeding were evaluated according to CT findings as small if there was peri splenic blood or blood in Morison's pouch, moderate if there was blood in one or both pericolic gutters, and large if there was the additional finding of free blood in the pelvis [10, 11]. Patients who showed deterioration of general condition were either admitted to ICU or shifted for urgent splenectomy.

The following demographic and clinical data were collected including age, gender, cause of injury, need for admission to intensive care unit (ICU) and duration of ICU stay, total duration of hospital stay.

Exclusion criteria

Patients younger than 18 years old, patients with a delayed presentation for >24 hours after trauma, patients who required urgent operative interference, immediate admission to ICU, died at the ED, referred patients with inadequate CT evaluation data, patients who had unstable hemodynamic parameter with systolic blood pressure (SBP) less than 90 mmHg and/or Hb. conc. of <7 gm/dl and patients required immediate interference for another indication other than the splenic injury.

Inclusion criteria

Patients with BSI, presented to ED within <24 hr., with stable hemodynamic parameters or stabilized after immediate resuscitation and with splenic injury of grade I-III, GCS of >9, small or moderate internal bleeding, no other abdominal injuries, and Hb. conc. of >7 gm/dl, and accepted to sign the informed consent to undergo the trial of NOM and to undergo splenectomy in case of failed NOM.

Study outcomes

1. The primary outcome is the success rate of NOM as defined as control of hemodynamic instability if present, stable splenic injury, the quantity of hemoperitoneum if present with no need for ICU admission for any indication.
2. Secondary outcomes include:
   - The distribution of patients of failed NOM between admission to ICU and surgical interference.
   - The survival rate of patients who had succeeded or failed NOM
   - The predictability of at admission data for the success of NOM without any adjuvant interference and survival.
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Statistical analysis

Obtained data were presented as mean, standard deviation, numbers, percentages, median and interquartile ranges. Results were analyzed using One-way ANOVA for analysis of variance between groups, Chi-square test (X^2 test) for analysis of non-numeric data, and Mann-Whitney test for median values. Predictability of at admission variables for NOM success and patients' survival was evaluated using the receiver operating characteristic (ROC) curve analysis judged by the area under the curve (AUC) compared versus the null hypothesis that AUC=0.05. The Automatic Linear Model Regression analysis was used for the stratification of variables as important predictors for NOM success and patient survival. Kaplan-Meier analysis was used to suggest a cutoff point of SBP to predict the outcome. Statistical analysis was conducted using IBM® SPSS® Statistics (Version 22, 2015; Armonk, USA) for Windows statistical package. P-value <0.05 was considered statistically significant.

Results

During the duration of the study, 407 BSI were directly admitted or referred to BUH; 183 patients were excluded, for hemodynamic instability (n=67), need for urgent surgery for other injuries (n=32), splenic injury of grades IV and V (n=38), inadequate CT data (n=19) of referred patients, delayed patients' referral (n=7) and refusal to undergo NOM (n=20). The study included 224 patients; 95 patients were of grade I, 68 patients were of grade II, and 61 patients were of grade III. Patients' enrolment demographic data and cause of trauma showed non-significant differences between patients categorized according to AAST grades. At admission, NISS scores of patients of Grade-III were significantly higher than scores of grade-I patients and non-significantly higher than scores of patients of grade-II. At admission GCS scores of grade-I patients were significantly higher than scores of patients with grade-I and II with a non-significant difference between patients with grade-II and patients with grade-III. At admission, SBP showed non-significant differences between patients of the three grades, while Hb. conc. was significantly lower in grade III patients in comparison to that of patients of grade I and II, with significantly lower conc. in grade II patients in comparison to grade I patients **(Table 1).**

Table 1: Patients' inclusion criteria

Variables		Splenic injury according to AAST grading system			Statistical significance (P-value)		
		Grade I (n=95)	Grade II (n=68)	Grade III (n=61)	I vs. II	I vs. III	II vs. III
Age (years)		39.6±11	41.5±9	39±8.7	0.479	0.943	0.299
Sex	Male	74 (77.9%)	50 (73.5%)	49 (80.3%)	0.519	0.717	0.362
	Female	21(22.1%)	18 (26.5%)	12 (19.7%)			
Cause of trauma	Vehicle	72 (75.8%)	46 (67.6%)	38 (62.3%)	0.229	0.187	0.516
	Fall	15 (15.8%)	18 (26.5%)	16 (26.2%)			
	other	8 (8.4%)	4 (5.9%)	7 (11.5%)			
NISS score*		16 [13-20]	16.5 [13-21.8]	18 [15-22.5]	0.582	0.0385	0.174
GCS score*		11 [10-12]	10 [10-12]	10 [9-12]	0.0315	0.0051	0.456
SBP (mmHg)		105.5±8.9	103.9±7.1	102.4±7.4	0.455	0.055	0.494
Hemoglobin conc		10.6±1.1	10±1	9.6±0.99	0.0017	<0.001	0.041

Data are presented as mean, standard deviation (±SD), numbers, percentages, median* and interquartile range; AAST: American Association for the Surgery of Trauma; NISS: New Injury Severity Scale; GCS: Glasgow Coma Scale; SBP: Systolic blood pressure; Hb. Conc.: Hemoglobin concentration; P-value indicates the significance of difference; P<0.05: indicates a significant difference; P>0.05: indicates a non-significant difference.

During the observation period at the intermediate care unit, 29 patients were admitted to ICU, 21 patients underwent

urgent splenectomy, and two patients deceased, while the remaining 172 patients completed their NOM uneventfully for a success rate of 76.8%. During ICU stay, 5 patients were shifted for elective splenectomy and 15 patients completed their NOM at ICU, while 9 patients were deceased. A total of 26 patients were shifted to surgery, 21 patients completed their postoperative course uneventfully and were discharged alive, while 5 patients died. Concerning total survival rates; 187 patients completed NOM and 21 had surgery and all these 208 patients were discharged alive for a total survival rate of 92.9%. The total survival rate after NOM (94.4%) was significantly (p=0.011) higher than the survival rate after surgery (80.8%). According to the AAST grading system, the survival rate of patients with grade I injury (97.9%) was significantly (p=0.0026) higher than the survival rate of patients of grade III (85.2%), but non-significantly (p=0.103) higher than that of patients of grade II (92.6%) with non-significantly (p=0.177) higher survival rate among patients of grade II in comparison to patients of grade III splenic injury **(Table 2, Fig. 1).**

Table 2: Outcome of studied patients as total and differentiated according to the AAST splenic injury grade

AAST Splenic injury Grade Outcomes		Total (n=224)	Grade I (n=95)	Grade II (n=68)	Grade III (n=61)
The outcome of patients admitted to the intermediate care unit					
Failed NOM (Deteriorated general condition &)	Admitted to ICU	29 (12.9%)	9 (9.5%)	13 (19.1%)	7 (11.5%)
	Shifted to surgery	21 (9.4%)	4 (4.2%)	4 (5.9%)	13(21.3%)
	Died	2 (0.9%)	0	1 (1.5%)	1 (1.6%)
Succeeded (Discharged alive)		172 (76.8%)	82 (86.3%)	50 (73.5%)	40 (65.6%)
Total		224			
The outcome of ICU patients					
Shifted to surgery		5 (17.2%)	0	3 (23.1%)	2 (28.6%)
Died		9 (31%)	2 (22.2%)	3 (23.1%)	4 (57.1%)
Completed NOM & discharged alive		15(51.8%)	7 (77.8%)	7 (53.8%)	1 (14.3%)
Total		29 (100%)	9 (100%)	13 (100%)	7 (100%)
The outcome of patients shifted to surgery					
Completed uneventful PO course		21 (80.8%)	4 (100%)	6 (85.7%)	11 (73.3%)
Died		5 (19.2%)	0	1 (14.3%)	4 (26.7%)
Total		26 (100%)	4 (100%)	7 (100%)	15 (100%)
Collective outcome					
Completed NOM & discharged alive		187 (83.5%)	89 (93.7%)	57 (83.8%)	41 (67.2%)
Had surgery & discharged alive		21 (9.4%)	4 (4.2%)	6 (8.8%)	11 (18%)
Total survival rate		208 (92.9%)	93 (97.9%)	63 (92.6%)	52 (85.2%)
Died at any care unit		11 (4.9%)	2 (2.1%)	4 (5.9%)	5 (8.2%)
Died after surgery		5 (2.2%)	0	1 (1.5%)	4 (6.6%)
Total mortality rate		16 (7.1%)	2 (2.1%)	5 (7.4%)	9 (14.8%)
Total		224 (100%)	95 (100%)	68 (100%)	61 (100%)

Data are presented as numbers, percentages; AAST: American Association for the Surgery of Trauma; NOM: Non-operative management; ICU: Intensive care unit; P-value indicates the significance of difference; P<0.05: indicates a significant difference; P>0.05: indicates a non-significant difference.

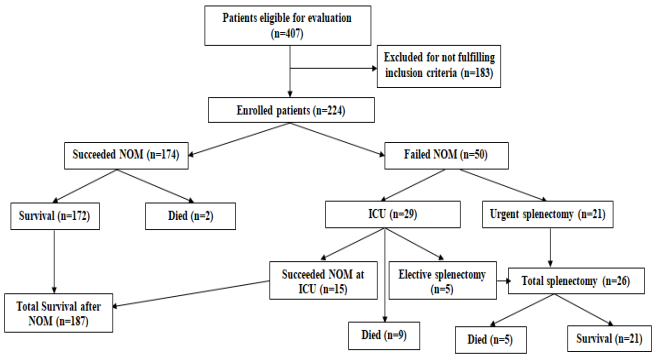

Fig. (1): Flow chart for outcome of studied patients

Mean operative time for patients who had operative interference was significantly shorter for patients who had grade I splenic injury in comparison to those who had grade II (p=0.0028) and III (p=0.0008) with non-significantly (p=0.839) shorter operative time for patients of grade II. Several transfused blood units for patients who had failed NOM and underwent surgical interference was significantly higher in comparison to several blood units transfused for patients who completed their NOM at the intermediate (p=0.0006) or intensive care units (p=0.005) with non-significantly (p=0.857) higher transfusion rate for patients who were shifted to ICU. Patients who completed their NOM uneventfully at the intermediate care unit had a significantly shorter duration of hospital stay in comparison to those admitted to ICU (P=0.0018) or underwent surgical interference (P=0.0031) with a non-significantly (P=0.749) longer duration of hospital stay for patients admitted to ICU in comparison to those had surgical interference **(Table 3).**

Table 3: Operative time for patients had surgical interference, number of transfused blood units, and length of hospital stay for studied patients

Variables	Splenic injury according to AAST grading system				Statistical significance (P-value)		
	Total	Grade I	Grade II	Grade III	I vs. II	I vs. III	II vs. III
Operative time (min.)*	**83.3±17**	**62.5±17.1**	**84.2±14.3**	**90.5±12.5**	**0.0028**	**0.0008**	**0.839**
Number of transfused blood units							
NOM	4 [3-6]	3 [3-4]	5 [4-5]	6 [5-7]	<0.001	<0.001	0.0002
ICU	4 [3-5]	4 [2-5]	4 [4-5]	6	0.704	-	-
Surgery	6 [4.5-7]	4 [3.25-5.5]	5.5 [3.75-7]	7 [6-8]	0.093	0.0036	0.107
Statistical significance (P-value)	NOM vs. ICU				0.857		
	NOM vs. Surgery				0.0006		
	ICU vs. Surgery				0.005		
Length of hospital stay (days)							
NOM	9.5 [8-12]	9 [8-10]	10 [9-12.3]	12 [9-16]	<0.001	<0.001	<0.001
ICU	12 [11-15]	12 [10-13]	13 [11-18]	23	0.276	-	-
Surgery	12 [10-15]	9 [7.25-11.5]	13.5 [11.5-15.75]	13 [10-16]	0.013	0.0091	0.803
Statistical significance (P-value)	NOM vs. ICU				0.0018		
	NOM vs. Surgery				0.0031		
	ICU vs. Surgery				0.749		

Data are presented as mean*, standard deviation (±SD), median and interquartile range; AAST: American Association for the Surgery of Trauma; NOM: Non-operative management; ICU: Intensive care unit; P-value indicates the significance of difference; P<0.05: indicates a significant difference; P>0.05: indicates a non-significant difference.

The success of NOM and survival of patients who had BSI was positively correlated with at admission SBP and Hb. conc., but negatively correlated with at-admission NISS score, AAST grade of splenic injury, and several transfused blood units. However, the correlation between the success of NOM and survival was non-significant **(Table 4).**

Table 4: Spearman's correlation analysis of successful NOM and survival and patients' data

Variables	Successful NOM		Survival	
	Rho.	P	Rho.	p
Age	-0.125	0.062	-0.106	0.113
Male gender	0.074	0.269	-0.006	0.928
NISS score	-0.294	<0.001	-0.298	<0.001
SBP (mmHg)	0.347	<0.001	0.299	<0.001
Hb. conc. (gm/dl)	0.305	<0.001	0.223	0.001
AAST grade of splenic injury	-0.268	<0.001	-0.174	0.009
Number of transfused blood units	-0.397	<0.001	-0.282	<0.001
Survival outcome	0.602	<0.001		

Rho: Spearman's correlation coefficient; NISS: New Injury Severity Scale; SBP: Systolic blood pressure; Hb. Conc.: Hemoglobin concentration; AAST: American Association for the Surgery of Trauma; P-value indicates the significance of Rho. ; P<0.05: indicates a significant difference; P>0.05: indicates a non-significant difference.

Stratification of these variables as regards their importance as predictors for success of NOM, the Automatic Linear Model Regression analysis arranged these variables as follows: high at admission Hb. conc. as the highly important predictor for NOM success by 47%, young age by 23%, normal SBP by 14%, low NISS score by 11%, and low AAST grade by 5% **(Fig. 2).** While for survival outcome, these variables were stratified as follows: young age by 36%, high Hb. conc. by 28%, normal SBP by 18%, low NISS scores by 14%, and low AAST grade by 4% **(Fig. 3).**

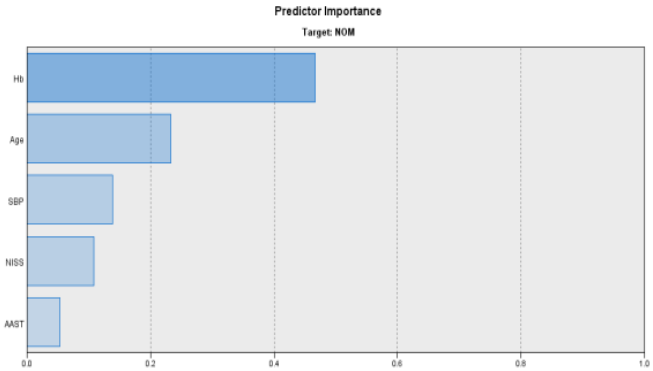

Fig. 2: The Automatic Linear Modeling Regression analysis curve for at-admission variables as predictors for success of NOM

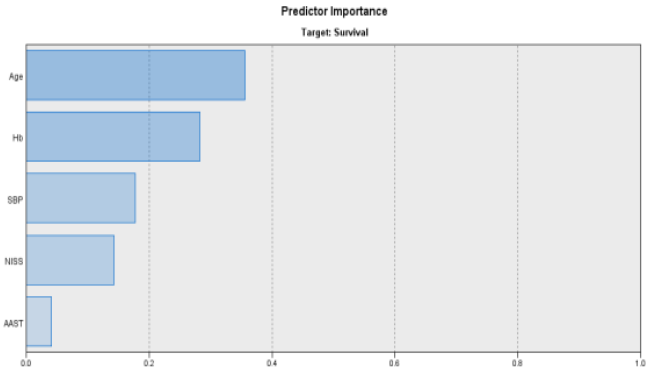

Fig. 3: The Automatic Linear Modeling Regression analysis curve for at-admission variables as predictors for survival outcome

However, ROC curve analysis defined normal SBP as a predictor for success of NOM and survival with high positive predictive value manifested as AUC= 0.769 (SE= 0.041, p<0.001, 95% confidence interval= 0.688-0.850) for NOM success and AUC =0.845 (SE= 0.046, p<0.001, 95% confidence interval= 0.755-0.935) for survival outcome. Also, ROC curve analysis defined low at-admission NISS score as a sensitive predictor for success of NOM with AUC= 0.272 (SE= 0.046, p<0.001, 95% confidence interval= 0.181-0.363) and survival outcome with AUC= 0.156 (SE= 0.048, p<0.001, 95% confidence interval= 0.062-0.251), **(Figs. 4,5).**

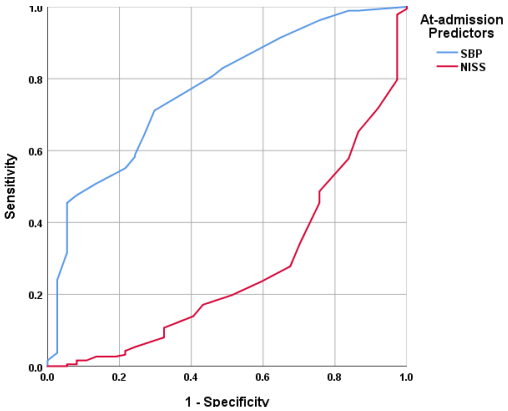

Fig. 4: ROC analysis curve for at-admission predictors for success of NOM with the highest positive predictive value and sensitivity rate

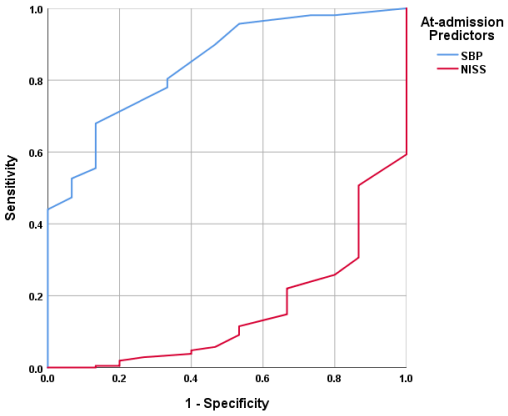

Fig. 5: ROC analysis curve for at-admission predictors for survival with the highest positive predictive value and sensitivity rate

Kaplan-Meier regression analysis defined SBP at a median value of 106 (SE= 1.306, 95% confidence interval= 103.44-108.56) as a cutoff point for increasing probability of success of NOM **(Fig. 6)** and at 104 (SE= 1.189, 95% confidence interval= 101.669-106.331) as a cutoff point for 50% probability of survival **(Fig. 7).**

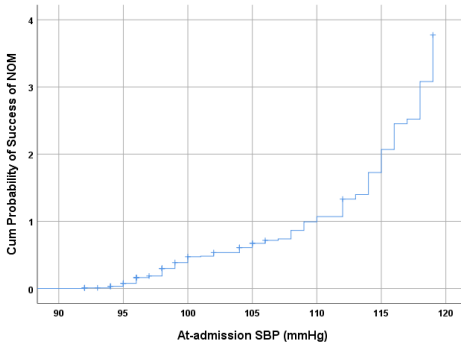

Fig. 6: Kaplan-Meier Regression analysis curve for at-admission SBP measures for the cumulative probability of success of NOM

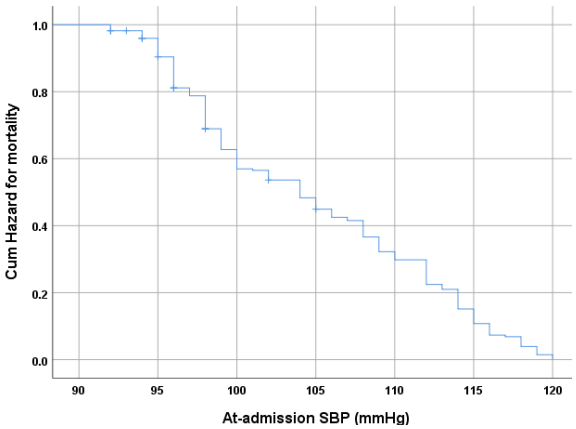

Fig. 7: Kaplan-Meier Regression analysis curve for at-admission SBP measures for the cumulative risk of mortality

Discussion

The current study detected a high success rate (83.5%) of non-operative management of patients with blunt splenic injury (BSI) with a high survival rate (94.4%). These results indicated that NOM of patients with BSI is effective management with high survival outcomes. In line with this finding, Goedecke et al. [12] detected a success rate of 90% for patients with blunt abdominal trauma who were initially managed non-operatively. Also, Lavanchy et al. [13] evaluated the outcome of NOM for 652 patients with BSI and reported an overall success rate of 86.5% and in-hospital mortality rate (MR) was 7.2%, so concluded that these results constitute the basis for further quality improvement in the care of splenic injury patients within the trauma system in Switzerland.

In support of the effectiveness of NOM, Teuben et al. [14] documented the NOM for BSI is a viable treatment modality even in patients with disturbed mental status (GCS<14) or neurologic impairment and Armstrong et al. [15]recommended NOM as safe and effective management for hemodynamically unstable patients with BSI, especially those with low-grade injuries. Also, Nijdam et al. [16] tried NOM with 28 patients with high-grade injuries; 20 Grade IV and 8 grade V injuries and reported success of NOM with 13 patients with grade IV, but the others underwent splenectomy. Furthermore, Liao et al. [17] documented that during the 12-year study period, the NOM rate increased from 56 to 73% and MR decreased from 8.9 to 7.2% with outcomes similar to operative management, which had more complications.

Patients who showed deterioration during NOM and required admission to ICU (n=29) had a higher mortality rate (37.5%) than those who completed their NOM free of decompensation episodes. Moreover, 26 patients were shifted from NOM to operative management; 5 of those admitted to ICU and MR of patients who had surgical interference was 15.4%. These findings indicated the association between failure of NOM and increased mortality rate, in support of this, correlation analysis detected a positive significant ($p<0.001$) correlation between the success of NOM and survival. Similarly, Bankhead-Kendall et al. [18] found patients who failed NOM had more complications and spent more days in ICU, and on the ventilator, and had higher mortality, and delayed splenectomy for patients who had failed NOM was independently associated with mortality.

The success of NOM and its survival outcome was negatively correlated with at-admission NISS, SBP, and hemoglobin concentration and with the need for a higher number of transfused blood units. Statistical analyses defined young age, low NISS score, and high SBP and hemoglobin concentration as the positive predictors for high success and survival rates of NOM and high at-admission SBP and low NISS score as the best predictors with high positive predictive value and sensitivity for the success of NOM. These correlations and outcomes of statistical analyses support that previously documented by Goedecke et al. [12] who reported that high severity of the injury as reflected by high ISS and greater need for blood transfusion, and old age are the significant predictors for high mortality during NOM for blunt abdominal trauma patients. Also, Nijdam et al. [16] found at-admission hemodynamic status and bleeding, not splenic injury grade were the drivers for splenectomy, and Bankhead-Kendall et al. [18] found transfusion in the first 24 h was independently associated with failed NOM.

These findings indicated that proper patients' selection for NOM is mandatory to achieve high success and survival rates of BSI patients. In line with this, Fodor et al. [19] recommended NOM for selected patients with blunt solid abdominal trauma for its associated low morbidities and mortalities. Also, Salottolo et al. [20] found the rate of application of splenic artery embolization as an adjuvant to NOM for hemodynamically stable patients with BSI increased by grade; 7% for grade I and II, 26% for grade III, 52%, and 85% for grades IV and V, respectively and found the significant predictors for the need for splenic artery embolization included severity of trauma and age. Also, Ruscelli et al. [21] recommended NOM for blunt abdominal organs trauma in hemodynamically stable or stabilizable patients regardless of the grade of lesions according to the AAST Organ Injury Scale. Moreover, Fransvea et al. [22] documented that NOM is a feasible and safe therapeutic alternative even in case of severe lesions in polytrauma patients, but the choice of NOM must be based on the hemodynamic stability indices, general trauma severity, and the spleen lesion severity.

Conclusion

Proper selection of BSI patients allowed a high success rate (83.5%) and survival rate (94.4%) of NOM. Young aged patients with low NISS scores and high SBP and hemoglobin concentration are the ideal candidate for NOM with suspected high success and survival rates, irrespective of the grade of injury according to the AAST CT grading system. High SBP and low NISS scores are the best predictors with high positive predictive value and sensitivity for the success of NOM.

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Injury severity evaluation tools

Appendix I.I: The New Injury Severity Score (NISS)

The injury severity scoring is an anatomical scoring system that provides an overall score for patients with multiple injuries. For each injury, an abbreviated injury scale (AIS) score is given and allocated to one of six body regions. The squared score of the three most severely injured body regions are added together to produce the NISS score which ranges between 0 and 75. If an injury is assigned an AIS of 6 (Unsurvivable injury), the NISS score is automatically assigned to 75. The NISS score correlates linearly with mortality, morbidity, hospital stay, and other measures of severity [(23)].

Body Region
Head
Face
Neck
Thorax
Abdomen
Spine
Upper Extremity
Lower Extremity
External & other

Score	Abbreviated Injury Scale (AIS)
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Un-survivable
Multiple injuries are scored by adding the squares of the highest AIS scores. The ISS can range between 1 and 75. ISS of a patient with an AIS of 6 in one region= 75	

Appendix I.III: Glasgow Coma Scale (GCS)

Variable	Points	Description

Eye Opening response	4	Spontaneous- Open with blinking at baseline
	3	To verbal stimuli, command, speech
	2	To pain only
	1	No response
Verbal response	5	Oriented
	4	Confused conversion, but able to answer questions
	3	Inappropriate words
	2	Incomprehensive speech
	1	No response
Motor response	6	Obeys commands for movement
	5	Purposeful movement to painful stimuli
	4	Withdraws in response to painful stimuli
	3	Flexion in response to pain (decorticate posturing)
	2	Extension response to pain (decerebrate posturing)
	1	No response

Head injury classification: GCS score of 13-15 indicates mild head injury, GSC score of 9-12 indicates moderate head injury, and score ≤8 indicates severe head injury [24]

Appendix I.III: American Association for the Surgery of Trauma Organ: Injury scale for Spleen [25]

Grade	Type	Description
I	Hematoma	Subcapsular, <10% of surface area
	Laceration	Capsular tear, <1cm parenchymal depth
II	Hematoma	Subcapsular, 10-50% of surface area Intraparenchymal, <5cm in diameter
	Laceration	Capsular tear, 1-3 cm parenchymal depth, but does not involve a trabecular vessel
III	Hematoma	Subcapsular, >50% of surface area, or expanding: ruptured subcapsular; Parenchymal: intraparenchymal hematoma >5cm or expanding
	Laceration	3 cm parenchymal depth, or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing devascularization of >25% of spleen
V	Laceration	Completely shattered spleen
	Vascular	Hilar vessels injury with devascularization of spleen