



Received: 28-01-2023
Accepted: 08-03-2023

ISSN: 2583-049X

Splenic Trauma; The Outcome of Conservative Vs Surgical Management; Latest Evidence and Future Steps

¹Dr. Amir Hamza Khan, ²Dr. Aamir khan, ³Dr. Asif din, ⁴Dr. Muhammad Siddique khan, ⁵Dr. Syed Majid Ali Shah, ⁶Dr. Basir Ullah

^{1, 2, 3, 5, 6} Post Graduate Resident, Department of Surgery, Khyber Teaching Hospital, Peshawar, Pakistan

⁴ Assistant Professor, Department of Surgery, Khyber Teaching Hospital, Peshawar, Pakistan

Corresponding Author: **Dr. Amir Hamza Khan**

Abstract

Objective: The purpose of this study is to review all the previous guidelines and literature regarding the management of splenic trauma and propose new comprehensive and practical ways and guidelines in the management of splenic trauma.

Study material and methodology: We used various search engines which included google scholar, PUBMED, science direct, web science and Cochrane science library. All the literature up to date was reviewed and compared for the best outcomes in management of splenic trauma by operative and

non-operative techniques.

Study Duration: we conducted our study for a minimum of 6 months duration from July to December 2022.

Study Design: Retrospective data review of medical literature.

Conclusion: Even though there were many variables discussed in previous studies, the most important decisive factor in planning management in splenic trauma patients is hemodynamic instability.

Keywords: Spleen, Trauma, Operative Management, Non-Operative Management

Introduction

The spleen is an organ found in virtually all vertebrates. Similar in structure to a large lymph node, it acts primarily as a blood filter^[1]. The spleen plays important roles in regard to red blood cells (erythrocytes) and the immune system^[2]. It removes old red blood cells and holds a reserve of blood as well. As a part of the mononuclear phagocyte system, it metabolizes hemoglobin removed from old red blood cells (erythrocytes)^[3]. The spleen synthesizes antibodies in its white pulp and removes antibody-coated bacteria and antibody-coated blood cells by way of blood and lymph node circulation^[4]. In humans the spleen is purple in color and is in the left upper quadrant of the abdomen^[5]. The spleen, in healthy adult humans, is approximately 7 centimeters (2.8 in) to 14 centimeters (5.5 in) in length.

Splenic injury usually results from blunt abdominal trauma. Significant impact (e.g., RTAs) can damage the spleen as can penetrating trauma (e.g., knife wound, gunshot wound). Splenic enlargement as a result of fulminant Epstein-Barr viral disease (infectious mononucleosis or post-transplant Epstein-Barr virus-mediated pseudo lymphoma) predisposes to rupture with minimal trauma or even spontaneously. Splenic injuries range from subcapsular hematomas and small capsular lacerations to deep parenchymal lacerations, crush injury, and avulsion from the pedicle. Diagnosis is made by computed tomography scan or ultrasonography^[6].

The management of splenic trauma has changed considerably in the last few decades especially in favor of non-operative management (NOM). NOM ranges from observation and monitoring alone to angiography/angioembolization (AG/AE) with the aim to preserve the spleen and its function, especially in children. These considerations are carried out considering the immunological function of the spleen and the high risk of immunological impairment in splenectomy patients^[6]. In contrast with liver traumatic injuries, splenic injuries can be fatal not only at the admission of the patient to the Emergency Department (ED), but also due to delayed subcapsular hematoma, rupture or pseudoaneurysm (PSA) rupture.

For these reasons, standardized guidelines in the management of splenic trauma are necessary^[7]. The existing classification of splenic trauma consider the anatomical lesions. However, patients' conditions may lead to an emergent transfer to the operating room (OR) without the opportunity to define the grade of the splenic lesions before the surgical exploration. This confirms the primary importance of the patient's overall clinical condition in these settings^[8]. In addition, the modern tools in bleeding management have helped in adopting a conservative approach also in severe lesions. Trauma management must be

multidisciplinary and requires an assessment of both the anatomical injury and its physiologic effects. The present guidelines and classification reconsider splenic lesions in the light of the pathophysiological status of the patient associated with the anatomical grade of injury and the other associated lesions^[9].

Discussion

The studies given below highlight this topic with evidence and greater detail as to how the management of splenic trauma has evolved and developed over the course of many years of experience and advancement in the medical field.

1. A study conducted by Shawky S. et al (2017) supports the non-operative management of splenic trauma. This prospective study included a total of 40 patients. The patients were managed conservatively or operatively. Non-operative management criteria included hemodynamic stability and absence of other injuries requiring laparotomy. Unstable patients were operated using splenectomy. Computed tomography was performed for stable patients only; grade I and grade II splenic injury comprised 70% of cases. The incidence of complications was 5% in the patients who were managed conservatively and 10% in the patients who were managed operatively ($\chi^2 = 0.360$; $P = 1.000$). There was no mortality in the patients who were managed conservatively, whereas in the patients who were managed operatively the incidence of mortality was 5% ($\chi^2 = 1.026$; $P = 1.000$)^[10].
2. Another study conducted in 2018 by Ahmed S, *et al.* goes in favor of non-operative management of splenic trauma irrespective of the grade of injury. This was a prospective study and contained total of 150 patients. Patients were divided into two groups: group I included patients who were hemodynamically stable, without signs of peritonitis, and group II included patients who were hemodynamically unstable and were managed operatively according to grade of injury by splenectomy, partial splenectomy, and selenography of a tear. In the first group, the minimum hospital stay was 5 days, the maximum was 9 days, and the mean were 6.40 ± 1.35 , whereas in the second group, the minimum of hospital stay was 5 days, and the maximum was 7 days, with mean of 6.0 ± 0.79 ^[11].
3. A case report was done by U. Kannan, B. Mishra, A. Subramanian *et al.* in 2014 in which discussion was done on management of splenic injury in a patient with proteus syndrome. This study suggested that non-operative management (NOM) should be abandoned, and operative management should be undertaken in splenic trauma if there is some pre-existing splenic pathology (like in this particular case of splenomegaly with possibility of splenic hemangioma)^[12].
4. A paper which provides "World Society of Emergency Surgery" classification of splenic injuries published by F. Coccolini, G. Montori, F. Catena *et al.* in 2017 provides comprehensive guidelines for the management of splenic trauma in adults and pediatric patients. The WSES classification divides spleen injuries into three classes: Minor (WSES class I) Moderate (WSES classes II and III) Severe (WSES class IV). The classification considers the AAST-OIS classification and the hemodynamic status and is the same for adult and pediatric patients^[13].
5. NOM is considered the gold standard for the treatment of patients with blunt splenic trauma (BST) who are hemodynamically stable after an initial resuscitation, in the absence of peritonitis and associated injuries requiring laparotomy. In high-volume centers with all facilities, the successful rate of attempted NOM is near 90%. NOM failure rate is reported to be between 4 and 15%. Several risk factors other than hemodynamic status have been reported including the need for red cell transfusions in ED or during the first 24 hours, hemoglobin and hematocrit levels at admission, HIV disease, cirrhosis, and drug addiction. In AAST-OIS injury grades above IV, the failure rate of NOM reaches 54.6%, while according to other studies, patients with III–V injury grades could achieve 87% of success rate. NOM failure in case of missed concomitant abdominal injuries is reported in 1–2.5% of cases. The risk of NOM failure in patients older than 55 years is still debated. Some authors suggested a primary operative management (OM) in the presence of hypotension in the ED, more than five red blood cells transfused, GCS < 11, high ISS, abdominal AIS > 3, age > 55, and spleen AAST-OIS injury grade > 3.^[13]
6. Laparotomy has been the gold standard in penetrating abdominal trauma. Pancreatic, diaphragmatic, and colic injuries significantly increase the rate of OM approach and mortality for septic complications. Demetriades *et al.* showed in a prospective study with 225 patients with penetrating splenic injury, the direct relationship between the degree of injury and the possibility of NOM vs. emergency laparotomy. Emergency laparotomy rate was 33% in grade I lesions, and it could increase up to 84% in the grade IV; all splenectomies were in injuries with grade III or higher. Operative management (OM) of splenic injuries should be performed in non-responder hemodynamic unstable patients. This condition is frequently observed in high-ISS trauma, in high-grade lesions, and in patients with associated lesions^[13].
7. The use of splenectomy is decreasing, and the use of splenorrhaphy is rarely adopted (35–24% and 6–1%, respectively). The attempt to perform a partial splenic salvage is reported in 50–78% of cases, but when NOM fails, splenectomy is the preferred treatment. Laparoscopic splenectomy for trauma is reported only in some cases of hemodynamically stable low-moderate grade splenic injuries. The reported overall hospital mortality of splenectomy in trauma is near 2%, and the incidence of post-operative bleeding after splenectomy, ranges from 1.6 to 3%, but with mortality near to 20%^[13].
8. A retrospective study of 301 adult splenic injuries presenting to the Princess Alexandra Hospital during a 15-year period, from 1970 to 1984, was conducted by N. Wetzig, R. Strong, D. Theile. About 25% of the ruptured spleens were preserved through splenorrhaphy. None of the cases of splenorrhaphy required re-operation for continued hemorrhage. Twenty-five per cent of all cases of splenic injury had associated intra-abdominal injury which would require laparotomy. A policy of operative management for splenic injury in adults with major trauma is therefore proposed because of the rate of associated intra-abdominal injuries^[14].

9. S. Arikan, A. Yucel, G. Adas, *et al.* conducted a study at Haseki Educational and Research Hospital Surgical Department in 2000. They studied feasibility of surgery for splenic trauma. About 184 patients were admitted with splenic injuries. There were 176 (95%) blunt and 8 (5%) penetrating injuries. The management of our cases involved splenectomy in 164 (89%), splenorrhaphy in 12 (7%) and partial splenectomy in 8 (4%). Exactly 172 (93%) of the operated patients had isolated splenic injuries and 12 (7%) concomitant organ injuries. The length of hospital stay of splenectomies; partial splenectomy and splenorrhaphy were 7.9, 7 and 6 days respectively. The complication rate of splenectomy, partial splenectomies; and splenorrhaphy after the operation were 3 (2%), 1 (0.5%) and 0. No deaths occurred as a result of splenic injury and operation^[15].
10. Another study by E. Sozuer, E. Ok, O. Banli *et al.* published in 2001. In this study, the patients who had traumatic splenic injuries were investigated and the results of surgical treatments were evaluated. There were 225 patients with traumatic splenic injuries, which contains 55 (24%) female and 170 (76%) males. Severity of splenic injury was classified. Splenectomy was performed in 203 (90%) patients, splenorrhaphy in 18 (8%) and partial splenectomy in 4 (2%) patients. The overall mortality was 12%. A positive correlation was estimated between the combined trauma and the mortality (Fisher's Chi-Square test; $\chi^2 = 9.538$, $p < 0.002$). In conclusion, non-operative treatment methods may prevent unnecessary splenectomies, especially in grade I and II blunt or penetrating splenic injuries^[16].
11. A study was carried out at the surgical department of Ayub Teaching Hospital from July 2001 to Dec 2002 to estimate the prevalence, severity and mode of splenic trauma and management technique from amongst the abdominal trauma cases admitted. Out of the 100 patients presenting in emergency, 25% presented with blunt and 75% with penetrating trauma. 97 patients underwent laparotomy and 03 treated conservatively. Out of these cases 19 patients had splenic injury, 6 (31.57%) with Type-I & II while 13 (68.42%) with Type-III & IV. 11 (57.89%) of the splenic injuries were due to blunt abdominal trauma and 8 (42.10%) due to penetrating abdominal injuries. 14 (83.6%) of the patients with splenic injury underwent splenectomy and 5 (26.3%) splenorrhaphy. It was concluded that the commonest cause of splenic injury was blunt abdominal trauma; assessment of the severity of splenic injuries at the time of laparotomy resulted in splenic salvage procedures in some cases^[17].
12. A study carried by N. Kaseje, S. Agarwal, M Burch *et al.* to understand the short-term outcomes of different types of management strategies for splenic injuries. A Retrospective descriptive study examining splenic injury management of adult patients at an urban level 1 trauma center. During 31 months, 170 splenic injuries were captured by the trauma registry. Eighty-five patients were managed nonoperatively, with 10 patients (11.9%) failing expectant management; they underwent subsequent splenectomies. Eleven patients were managed by splenic artery embolization. Three patients (27.2%) required further intervention; 1 required re-embolization; and 2 required splenectomy. Sixteen patients underwent surgical splenorrhaphy, with 2 patients failing (12.5%), thus requiring eventual splenectomies. Morbidity for splenic preservation (observation, splenic embolization, and splenorrhaphy) was 13.4%, whereas morbidity for splenic salvage (embolization and splenorrhaphy) was 18.5%. This study concluded that in adult population, splenic preservation has 2-fold and splenic salvage close to 3-fold morbidity compared with immediate splenectomy in management of patients with blunt and penetrating splenic injuries^[18].
13. A review study done by Lucas and Charles E, in 1991 set the stage for routine splenectomy, which was performed for all splenic injury in the next two generations. Intraoperative splenic salvage has become more popular and can be achieved safely in most patients by delivering the spleen with the pancreas to the incision, carefully repairing the spleen under direct vision, and using the many adjuncts to suture repair, including hemostatic agents and splenic wrapping. Intraoperative splenic salvage is not indicated in patients actively bleeding from other organs or in the presence of alcoholic cirrhosis. The role of splenic replantation in those patients requiring operative splenectomy needs further study but may provide significant long-term splenic function. Patients with intrasplenic hematomas or with splenic fractures that do not extend to the hilum as judged by computed tomography usually can be observed successfully without operative intervention and without blood transfusion. Nonoperative splenic salvage is less likely with fractures that involve the splenic hilum and with the severely shattered spleen; these patients usually are treated best by early operative intervention^[19].
14. During the 20-year study done by R. Stolee, T. Cogbill, P. Srutt ending in December 1987, 179 consecutive splenic trauma patients were treated at a single institution. Procedures included splenectomy in 121 (67%) patients, splenectomy with auto transplantation in 7 (4%), splenorrhaphy in 23 (13%), laparotomy alone in 7 (4%), and nonoperative management in 21 (12%). Before 1976, all patients were treated by splenectomy. Since 1980, 18 (22%) were treated nonoperatively, 26 (33%) by splenic salvage techniques, and 36 (45%) by splenectomy. We conclude that nonoperative therapy and splenic salvage techniques are being employed with increasing frequency. In the presence of severe splenic or associated injuries, splenectomy remains the procedure of choice^[20].
15. A retrospective analysis of prospective database conducted by D. Bagaria, A. Kumar, A. Ratan *et al.* The aim of this study was to compare NOM and OM for isolated splenic injury in an Indian Level 1 Trauma Center. A Total of 129 patients admitted with diagnosis of isolated splenic injury from January 2009 to December 2016 were included in the study. Ninety-two (71.3%) patients with isolated splenic trauma were successfully managed non-operatively. Thirty-seven (28.7%) required surgery. Patients with isolated splenic trauma requiring OM had higher grade splenic injury (Grade 4/5), higher blood transfusion requirements ($P < 0.001$), and prolonged Intensive Care Unit and hospital stay in comparison to patients in the nonoperative group. No patient died in the NOM group; two patients died in the splenectomy group due to hemorrhagic

- shock and acute respiratory distress syndrome, respectively. Although NOM is successful in most patients with blunt isolated splenic injuries, careful selection is the most important factor dictating the success of NOM [21].
16. A retrospective analysis on the use of Gelfoam splenic artery embolization (SAE) as an alternative to operative management in blunt splenic trauma was conducted on 132 patients admitted to a level 1 trauma center between January 2014 and December 2015. Gelfoam SAE was performed in 25 (18.9%) of the 132 patients. Gelfoam SAE patients had fewer ICU days compared with those patients who had a splenectomy or NOM. There was no statistical difference in complications between patients who underwent Gelfoam SAE and those who did not. Patients who underwent Gelfoam SAE tended to have fewer complications including deep venous thrombosis's, PE, and infections and yielded no complications in 64% of the Gelfoam group [22].
 17. Meira Júnior and her team supervised a critical systemic analysis of the most recent literature on this topic, exposing the state of the art in the NOM of splenic trauma. They pointed out that several topics regarding the nonoperative management (NOM) of splenic trauma are still controversial. Splenic angioembolization is a very useful tool for NOM, but there is no consensus on its precise indications. There is no definition in the literature as to how NOM should be conducted. NOM of blunt splenic injuries can be indicated in every hemodynamically stable patient, provided there are adequate resources in the hospital and there are no associated lesions that require surgical exploration [23].
 18. A shift from operative management (OM) to non-operative management (NOM) has occurred over the past decades where NOM has now become the standard of care in hemodynamically stable patients with blunt splenic injury. Splenic artery embolization (SAE) is generally believed to increase the success rate of NOM. The available evidence (although with a relatively small number of patients) shows that splenic function is preserved after NOM, a major advantage compared to splenectomy. SAE is used as an adjunct to observation in order to increase the success rate of NOM. Operative management should be applied in case of hemodynamic instability or if associated intra-abdominal injuries requiring surgical treatment are present [24].
 19. Trauma registry and medical record review identified all consecutive patients presenting to LAC+USC Medical Center with penetrating splenic injury between January 2001 and December 2011. Although the vast majority of penetrating splenic trauma requires urgent operative management, a group of patients does present without hemodynamic instability, peritonitis or radiologic evidence of hollow viscus injury. During the study period, 225 patients experienced penetrating splenic trauma. The majority (187/225, 83%) underwent emergent laparotomy. Thirty-eight clinically stable patients underwent a deliberate trial of NOM and 24/38 (63%) were ultimately managed without laparotomy. Amongst patients failing NOM, 3/14 (21%) underwent splenectomy while an additional 6/14 (42%) had splenorrhaphy. Hollow viscus injury (HVI) occurred in 21% of all patients failing NOM. Forty percent of all NOM patients had diaphragmatic injury (DI). In clinically stable patients, diagnostic laparoscopy remains essential to evaluate and repair occult DI. As NOM for penetrating abdominal trauma becomes more common, multi-center data is needed to more accurately define the principles of patient selection and the limitations and consequences of this approach in the setting of splenic injury [6].

Table 1: Studies, references and conclusions in tabulated form

Author	Design	Sample	Aim of study	Results/Conclusion
Gad SS <i>et al</i> ¹⁰	Prospective study	40	Operative versus conservative management of splenic trauma in pediatric patients	Nonoperative management is considered the ideal management for blunt splenic injuries in pediatric patients because of fewer complications.
El AS <i>et al</i> ¹¹	Prospective study	150	Different treatment modalities in traumatic splenic injuries.	NOM for blunt splenic trauma in hemodynamically stable patients is safe, effective, and associated with low morbidity and no mortality.
Kannan U <i>et al</i> ¹²	Case report	1	Operative management of splenic injury in a patient with proteus syndrome.	We suggest that non-operative management (NOM) should be abandoned, and operative management should be undertaken in splenic trauma if there is some pre-existing splenic pathology.
Coccolini F <i>et al</i> ¹³	Case series/multicentric study	N/S	Splenic trauma: WSES classification and guidelines for adult and pediatric patients.	NOM is considered the gold standard for the treatment of patients with blunt splenic trauma (BST) who are hemodynamically stable after an initial resuscitation, in the absence of peritonitis and associated injuries requiring laparotomy.
Wetzig NR <i>et al</i> ¹⁴	Retrospective study	301	Splenorrhaphy in the management of splenic injury.	A policy of operative management for splenic injury in adults with major trauma is therefore proposed because of the rate of associated intra-abdominal injuries.
Arikan S <i>et al</i> ¹⁵	Prospective study	184	Survey of the feasibility of surgery for splenic trauma.	The length of hospital stays and the complication rates are relatively higher in splenectomies as compared to partial splenectomy and splenorrhaphy. No deaths occurred as a result of splenic injury and operation.
Sözüer EM <i>et al</i> ¹⁶	Retrospective study	225	Assesment of traumatic splenic injuries.	Splenectomy is the frequently used surgical method for the treatment of traumatic splenic injuries. Non-operative treatment methods may prevent unnecessary splenectomies, especially in grade I and II blunt or penetrating splenic injuries.
Mufti TS <i>et al</i> ¹⁷	Prospective study	100	Experience with splenic trauma in Ayub Teaching Hospital	The commonest cause of splenic injury was blunt abdominal trauma; Assessment of the severity of splenic injuries at the time of laparotomy resulted in splenic salvage procedures in some cases.

				Splenorrhaphy was associated with fewer complications.
Kaseje N <i>et al</i> ¹⁸	Retrospective study	170	Short-term outcomes of splenectomy avoidance in trauma patients	In the adult population, splenic preservation has 2-fold and splenic salvage close to 3-fold morbidity compared with immediate splenectomy in management of patients with blunt and penetrating splenic injuries.
Lucas CE <i>et al</i> ¹⁹	Systemic review	N/S	Splenic trauma: Choice of management.	Patients with intrasplenic hematomas or with splenic fractures that do not extend to the hilum as judged by computed tomography usually can be observed successfully without operative intervention and without blood transfusion.
Stolee RT <i>et al</i> ²⁰	Prospective study	179	Trends in the management of splenic trauma	We conclude that nonoperative therapy and splenic salvage techniques are being employed with increasing frequency. Selective application of splenorrhaphy for injuries with a realistic expectation of success has resulted in no late procedures for hemorrhage. In the presence of severe splenic or associated injuries, splenectomy remains the procedure of choice.
Bagaria D <i>et al</i> ²¹	Retrospective study	1496	Changing aspects in the management of splenic injury patients: Experience of 129 isolated splenic injury patients at level 1 trauma center from India	Patients with isolated splenic trauma requiring OM had higher grade splenic injury (Grade 4/5), higher blood transfusion requirements ($P < 0.001$), and prolonged Intensive Care Unit and hospital stay in comparison to patients in the nonoperative group.
Freeman C <i>et al</i> ²²	Retrospective study	132	Nonoperative Management of Blunt Splenic Trauma: Outcomes of Gelfoam Embolization of the Splenic Artery	Nonoperative management (NOM) is the standard of care in hemodynamically stable trauma patients with blunt splenic injury. Gelfoam splenic artery embolization (SAE) is a treatment option used in trauma patients.
Meira Júnior JD <i>et al</i> ²³	Systemic review	N/S	Non-operative management of blunt splenic trauma: evolution, results and controversies.	There is no definition in the literature as to how NOM should be conducted, neither about the periodicity of hematimetric control, the transfusion threshold that defines NOM failure, when to start venous thromboembolism prophylaxis, the need for control imaging, the duration of bed rest, and when it is safe to discharge the patient.
Olthof DC <i>et al</i> ²⁴	Descriptive study	N/S	Evidence-Based Management and Controversies in Blunt Splenic Trauma. Current trauma reports	Nowadays, NOM is the standard of care in hemodynamically stable patients with blunt splenic injury. Splenic artery embolization is used as an adjunct to observation in order to increase the success rate of NOM. Operative management should be applied in case of hemodynamic instability or if associated intra-abdominal injuries requiring surgical treatment are present.
Berg RJ <i>et al</i> ⁶	Systemic review	225	The contemporary management of penetrating splenic injury	Although the vast majority of penetrating splenic trauma requires urgent operative management, a group of patients does present without hemodynamic instability, peritonitis or radiologic evidence of hollow viscus injury. Management of these patients is complicated as over half may remain clinically stable and can avoid laparotomy, making them potential candidates for a trial of NOM.

Funding

This study was self-funded by the authors.

Conflict of interest

There was no conflict of interest.

References

- Henry George Liddell, Robert Scott. A Greek-English Lexicon, on Perseus Digital Library.
- Darling David. spleen. www.daviddarling.info
- Mebius RE, Kraal G. Structure and function of the spleen. *Nature Reviews. Immunology*. 2005; 5(8):606-616. Doi: 10.1038/nri1669. PMID 16056254
- Swirski FK, Nahrendorf M, Etzrodt M, Wildgruber M, Cortez-Retamozo V, Panizzi P, *et al*, 2009.
- Jia T, Pamer EG. *Immunology*. Dispensable but not irrelevant. *Science*. 2009; 325(5940):549-550.
- Berg RJ, Inaba K, Okoye O, Pasley J, Teixeira PG, Esparza M, *et al*. The contemporary management of penetrating splenic injury. *Injury*. 2014; 45(9):1394-1400.
- Finally, the Spleen Gets Some Respect by Natalie Angier, *The New York Times*, August 3, 2009.
- Nonoperative management of blunt hepatic injury: An Eastern Association for the Surgery of Trauma practice management guideline. *J Trauma Acute Care Surg* 73:S288-S293, 2012.
- Oxford Centre for Evidence-based Medicine - Levels of Evidence, March 2009. - CEBM. Available from: <http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidence>
- Gad SS, Sultan TA, Dwedar MA. Operative versus conservative management of splenic trauma in pediatric patients. *Menoufia Med J*, 2019, 1145-1150.
- El AS, Abo AM, Nabil AM. Different treatment modalities in traumatic splenic injuries, 2020, 1322-1327.
- Kannan U, Mishra B, Subramanian A, Sagar S, Kumar S, Singhal M. Operative management of splenic injury in a patient with proteus syndrome. *J Emergencies, Trauma Shock*. 2014; 7(3):233-235.
- Coccolini F, Montori G, Catena F, Kluger Y, Biffl W, Moore EE, *et al*. Splenic trauma: WSES classification and guidelines for adult and pediatric patients. *World J Emerg Surg*. 2017; 12(1):1-26.
- Wetzig NR, Strong RW, Theile DE. Splenorrhaphy in the management of splenic injury. *Aust NZJ Surg*. 1986; 56(10):781-784.

15. Arıkan S, Yücel AF, Adaş G, Culcu D, Gülen M, Arınç O. [Splenic trauma and treatments. Haseki Educational and Research Hospital Surgical Department survey of the feasibility of surgery for splenic trauma]. *Ulus Travma Derg* [Internet]. 2001 Oct 1 [cited 2022 Sep 24]; 7(4):250-253. Available from: <https://europepmc.org/article/med/11705080#similar-articles>
16. Sözüer EM, Ok E, Banlı O, Ince O, Kekeç Z. Traumatic splenic injuries. *Ulus Travma Derg*. 2001; 7(1):17-21.
17. Mufti TS, Akbar I, Ahmed S. Experience with splenic trauma in Ayub Teaching Hospital, Abbottabad. *J Ayub Med Coll Abbottabad*. 2007; 19(3):3-5.
18. Kaseje N, Agarwal S, Burch M, Glantz A, Emhoff T, Burke P, *et al*. Short-term outcomes of splenectomy avoidance in trauma patients. *Am J Surg*. 2008 Aug; 196(2):213-217.
19. Lucas CE. Splenic trauma: Choice of management. *Ann Surg*. 1991; 213(2):98-112.
20. Stolee RT, Cogbill TH, Strutt PJ. Trends in the management of splenic trauma. *Wisconsin Medical Journal*. 1990; 89:267-270.
21. Bagaria D, Kumar A, Ratan A, Gupta A, Kumar A, Kumar S, *et al*. Changing aspects in the management of splenic injury patients: Experience of 129 isolated splenic injury patients at level 1 trauma center from India. *J Emergencies, Trauma Shock*. 2019; 12(1):35-39.
22. Freeman C, Moran V, Fang A, Isreal H, Ma S, Vyas K. Non-operative Management of Blunt Splenic Trauma: Outcomes of Gelfoam Embolization of the Splenic Artery. *Journal of emergencies, trauma, and shock*. 2018; 11(4):293-297.
23. Meira Júnior JD, Menegozzo CAM, Rocha MC, Utiyama EM. Non-operative management of blunt splenic trauma: Evolution, results and controversies. *Revista do Colegio Brasileiro de Cirurgioes*. 2021; 48:e20202777.
24. Olthof DC, van der Vlies CH, Goslings JC. Evidence-Based Management and Controversies in Blunt Splenic Trauma. *Current trauma reports*. 2017; 3(1):32-37.