Outcome of Post Splenectomy Pancreatic Fistula according to the Updated Definition and Grading of the International Study Group of Pancreatic Fistula (ISGPS)

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Background: Splenectomy is a widespread surgical procedure. All splenectomies share the risk of pancreatic injury during surgery and the emergence of a postoperative pancreatic fistula (POPF). A widely accepted definition and grading system for POPF was created by the International Study Group of Pancreatic Fistula (ISGPS).

The aim of this study: To analyze the outcome of POPF following splenectomy according to the updated definition and grading of ISGPS.

Methodology: This was a retrospective and prospective cohort study of patients who developed POPF after open splenectomy at department of surgery, King Abdul-Aziz hospital at Taif, Ministry of health, Saudi Arabia, from December 2017 to December 2022.

Results: 1672 patients underwent open splenectomy. The percentage of patients who developed POPF/biochemical leak (BL) was 12.8%. The BL rate was 7.4%, whereas the POPF rate was 5.4%; 4.1% had grade B & 1.3% developed grade C. Multivariate analysis validated the primary vs secondary splenectomy indication, GI malignancy as a secondary splenectomy indication, and length of hospital stay as independent risk factors for the occurrence of POPF/BL. BL occurred in 4.6% post-primary splenectomies and 9.5% of post-secondary splenectomies, and grade B POPF occurred in 3.7% of post-primary splenectomies and 4.3% of post-secondary splenectomies patients, while grade C POPF was noted in 0.85% of post-primary splenectomies and 1.7% of post-secondary splenectomies patients.

Conclusion: The 2016 modified definition & classification of ISGPS for POPF is a straightforward, helpful criteria for categorizing POPF that continues to be the fundamental step in creating strategies for avoiding and managing POPF.

Key words: Pancreatic fistula, ISGPS, biochemical leak, splenectomy, POPF.

Introduction

Splenectomy is a widespread surgical procedure, with an annual incidence of around 6.4-7.1 per 100,000 people worldwide. Trauma and hematological disorders are the most frequent indications for it.[1]

Depending on the patient's status and diagnosis splenectomy can be performed using open, laparoscopic, or robotic procedures.[2]

Splenectomy has developed into a well-recognized surgical operation since Quittenbaum made the first intentional removal of a diseased spleen in 1826. Post splenectomy life was believed to be relatively risk-free till 1952, when King & Schumacher raised awareness of the possibility of severe post-splenectomy infection (OPSI). Since then, interest in splenectomy has decreased.[3]

The spleen is an outstanding organ that supports effective erythrocyte phagocytosis and iron recycling, capture and elimination of pathogens, and activation of adaptable immune reactions. These different tasks are only performed in one organ through compartmentalization into different zones with modifications not seen in any other lymphoid organ.[4]

However, the majority of splenectomies are required to treat diseases that either have the spleen as their primary site of involvement or that are associated with hemolysis or thrombocytopenia. As a result, there are three main categories of splenectomy indications: primary splenectomy for diseases related to the spleen, secondary splenectomy for oncological or functional causes outside the spleen, and post traumatic splenectomy.[5]

Splenectomy is indicated as a life-saving surgery in traumatic situations, a therapeutic operation in hematological disorders, a life-preserving therapy in malignant diseases, and a method for disease diagnosis.[1]

The main cause of splenectomy in most medical centers is trauma, however this becomes less common at the current time as non-operative strategies for splenic trauma are being used.[6]

The complications due to splenectomy can be categorized as infectious and non-infectious. The immune response to infection in these patients has suppressed, and sepsis can readily develop in them. Also, splenectomy has been reported to be a factor in postoperative vascular complications. Pulmonary hypertension may occur after splenectomy as a

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fulminant complication.[7]

The Clavien–Dindo classification is a widely used classification gradient system for postoperative complications. It is a common system to categorize postoperative complications according to their plan of therapy. For example, a complication that necessitates re-laparotomy is worse than that requires "only" blood transfusion. Literature has widely adopted the Clavien-Dindo classification, and outdated expressions like minor or major complications are now much less frequently used.[8]

Despite the wide range of indications, all procedures share the risk of pancreatic injury during surgery and the emergence of a postoperative pancreatic fistula (POPF).[9]

A considerable percentage of patients undergoing splenectomy unintentionally had pancreatic injury.[10]

Approximately 1-3% of patients who undergo splenectomy get postoperative pancreatic injury.[11]

There is a lack of data on the correlation between POPF and splenectomy, particularly primary splenectomy; a few studies give information on post splenectomy POPF in selected patients with liver cirrhosis or hepatolenticular degeneration. All further data was collected from patients who underwent secondary splenectomy surgery, in which the splenectomy was a secondary target but not the primary one. This results in significant bias due to the participation of other factors like resection size, surgical technique, and intraoperative plans. This hinders the proper evaluation of splenectomy-specific incidence of POPF, risk factors, or algorithms of therapy.[5]

Therefore, post splenectomy pancreatic fistula requires great attention because of the higher rates of morbidity and mortality & as well as the expense and requirement for resources to treat affected patients.[12]

Clinically, a pancreatic fistula is defined as the presence of drainage fluid containing three times more amylase than the upper limit of serum amylase three days after surgery, closely correlated to the prognosis of clinical management. As a result, amylase is typically thought of as a ticking time bomb for the development of pancreatic fistula. Rise of this index frequently suggests pancreatic abnormality. By keeping an eye on the amylase, help for close observation of pancreatic fistula development and safety of postoperative patients can be obtained.[13]

A widely accepted diagnosis and grading system for postoperative pancreatic fistula was created by the International Study Group of Pancreatic Fistula (ISGPS) in 2005. After 11 years, the International Study Group of Pancreatic Fistula classification has taken the lead in defining postoperative pancreatic fistula in clinical practice because pancreatic fistula continues to be one of the most important and dangerous complications postoperatively. In 2017, the International Study Group of Pancreatic Fistula (ISGPS) suggested an updated definition and grading system for postoperative pancreatic fistula that allowed for a better comparison of approaches used to minimize the rate and clinical consequences caused by pancreatic fistula. Using this new classification system also made it possible to compare surgeons' and surgical units' abilities more precisely.[9]

Studies are currently being conducted to anticipate the risks and outcomes due to the higher likelihood of complications. The increased level of amylase in the drain fluid more than 1300 U/L on the first postoperative day is a predictor & indicator of risk for developing a postoperative pancreatic fistula. Multicenter prospective studies will need to validate the diagnostic utility and suggested cut-off levels of drain fluid amylase Day 1 in predicting the postoperative pancreatic leakage.[14]

Aim of the study

The aim of this study was to analyze the outcome of splenectomy-associated postoperative pancreatic fistula (POPF) over five years according to the updated definition and grading of the International Study Group of pancreatic surgery (ISGPS). medical records of 1672 patients with open splenectomy in our unit were analyzed retro- & prospectively from December 2017 till December 2022.

Patients and methods

This was a retrospective and prospective single-center database cohort study to patients who developed postoperative pancreatic fistula (POPF) after open splenectomy whether elective or emergent & admitted to our department of surgery, King Abdul-Aziz specialized hospital (KAASH) at Taif, Ministry of health (MOH), Saudi Arabia, in the period between December 2017 and December 2022. each patient signed preoperative consent for the use of related prospective database for research purposes.

Inclusion & exclusion criteria:

Our inclusion criteria were all patients who underwent open splenectomy for any indication. Each patient for open splenectomy was assessed preoperatively by anesthesia team and categorized according to the American Society of Anesthesiologists (ASA) physical status classification system (ASAPS). **(Table 1).**

patients who underwent open splenectomy with simultaneous pancreatic surgery or those underwent splenectomy in other surgical departments and then transferred to our ward were excluded.

Data collection:

Data was extracted from preoperative and operative data records, post-operative, and follow-up files.

Patient data:

I. Preoperative variables:

A- Demographic findings:

- Age.
- Gender: male or female.
- Body Mass index (BMI) = weight in kilograms divided by height in meters squared (kg/m2)
- Occupation.
- Residence.
- Special habits of medical importance: smoking or alcohol consumption

B- History & clinical examination:

- Symptoms and physical signs.
- Past history including co-morbidity especially diabetes mellitus (DM) & hypertension (HTN), previous surgical history & drug history
- Indications of splenectomy: whether primary or secondary.

C- Investigations:

- Laboratory study: Complete blood picture (CBC) with film, liver & kidney function tests, coagulation & hypercoagulability profile, serum electrolytes & blood gases, hematology profile and tumor markers.
- **Imaging studies:**

1. **Chest X-ray with/without CT chest:** for preoperative assessment and detection of post operative chest complications post splenectomy
2. **Ultrasonographic findings (U/S):**

   ► **Preoperative:** was the routine diagnostic imaging method in all patients for presence of fluid collection or splenic injury during Focused Assessment With Sonography in Trauma (FAST) in case of trauma, primary diagnosis of splenomegaly with/without hepatomegaly, any splenic or other organ lesion or lymphadenopathy. Also, US Doppler was useful in diagnosis of thrombosis of portal vein (PV), superior mesenteric vein (SMV) or splenic vein (SV).

   ► **Postoperative:** first imaging study in detection of post operative complications e.g., intra-abdominal collection in case of bleeding or POPF. Also, US guided aspiration and/or drainage was used for drainage of intraabdominal collections in case of POPF.

3. **Triphasic abdominal C.T.:**

   ► Preoperative: was not routinely done in all patients. It was done for patients highly suspicious for malignancy, splenic lesions or infarction, confirmatory diagnosis in hemodynamically stable patients post trauma with positive FAST

   ► Postoperative: detection of post operative complications e.g., intraabdominal collections. Angiography was done for diagnostic purposes e.g., vascular complications & curative purposes e.g., angioembolization in cases of POPF related bleeding. Also, CT guided aspiration and/or drainage was used for drainage of intraabdominal collections in case of POPF if failed with US.

4. **MRI abdomen with or without contrast:**

   ► Preoperative: also, was not routinely done in all patients. It was done to confirm diagnosis in some cases and assess biliary or pancreatic issues if suspected by US abdomen.

   ► Postoperative: for assessment of pancreatic duct & confirm site of leak in cases of POPF.

5. **Endoscopic retrograde cholangiopancreatography (ERCP): was done mainly postoperatively to confirm diagnosis and stenting of CBD and pancreatic duct of possible.**

- **Invasive procedures for diagnosis:**

1. Upper endoscopy: to assess presence of varices in case of portal hypertension & detect any esophageal, gastric, or duodenal lesion.
2. Bone marrow biopsy: to confirm diagnosis of hypersplenism & exclude features of bone marrow depression.
3. Liver biopsy.
4. Splenic lesion biopsy.

II. Intra-operative variables:

A. Time of surgery whether daytime or nighttime (according to our policy, daytime hours were between 7:00 am and 10:00 pm, while nighttime hours were between 10:00 pm and 7:00 am)

B. Extent of splenectomy: Whether full or partial.

C. Duration of surgery (Minutes).

D. Weight of spleen (gm).

E. Intraoperative complications.

◇ **Technical issues:**

- The customary surgical technique in our department for open splenectomy was as follows; first, the patient was then put in supine position, and a time-out was taken to confirm that the patient, technique, site, and any other information were correct. Following endotracheal intubation, the proper placement of lines and tubes (such as arterial lines, a foley catheter, a nasogastric tube, or an orogastric tube with sequential compression devices) was carried out. A sterile drape was used to prepare and cover the abdomen. We either used a midline incision (from the xiphoid process to the symphysis pubis) or a left subcostal incision (from the midline to the anterior axillary line) and extended deeply through the skin, subcutaneous tissue, and fascia layers into the peritoneal cavity. Then, inspection of the four abdominal quadrants was done. For proper retraction and visualization, a Book Walter or Codman retractor was set up. Following adhesolysis, entering into the lesser sac was achieved incising the gastrocolic ligament that was followed by division & ligation of the gastrosplenic and splenocolic. Then, the spleen was pushed medially exposing the retroperitoneal attachments, and the splenorenal and splenophrenic ligaments were divided and ligated. In this instance, the splenic artery and vein could be ligated close to the hilum using suture or a vascular load stapler while taking extreme care to the pancreatic tail during dividing vessels to avoid pancreatic injury **(Fig. 1).** In order to avoid any spillage that would cause splenosis (The breaking off of splenic tissue with implantation of it in other locations), the spleen was carefully delivered out. A closed-suction drain was inserted after hemostasis and a careful examination for any suspicious pancreatic injury. Inspection for any accessory spleen, which is most frequently found in the hilum and should be removed if identified, was the most crucial step. At the end, the fascia was closed & stitching of the skin edges with staples, interrupted Prolene or running subcuticular suturing.

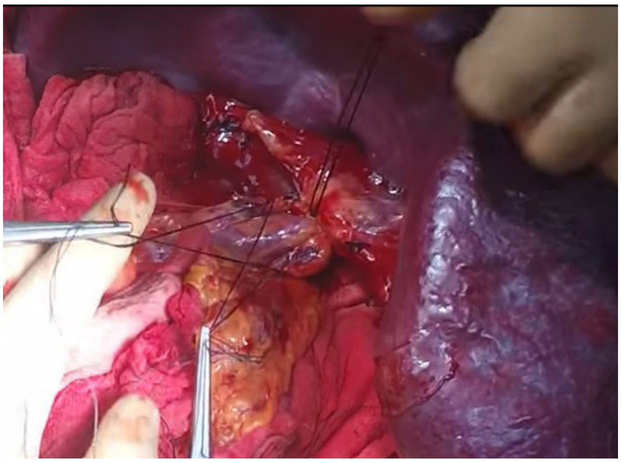

Fig 1: Showing splenic artery and vein ligation close to the splenic hilum.

I. Postoperative variables:

A. Postoperative complications (other than POPF) according to modified Clavien-Dindo classification:

Accurate interpretation of post-surgical outcome has been impeded for a long time by the lack of a consensus definition and universally accepted grading system for postoperative complications.16 There has been inconsistent use of terms like minor, moderate, major, or severe problems among researchers, medical centers, and over time periods. In 1992, a revolutionary method for classifying postoperative complications by severity depending on the therapy relied on to treat them was introduced. This method distinguished between three types of adverse postoperative outcomes: complications, failure to cure, and sequelae.[17]

After that, Clavien et al. (1994)[18] modified the original grading classification relying greatly on the therapy needed for treatment of the postoperative complication to reflect the severity of this complication. This is especially useful in retrospective analyses when complications might not be fully documented while diagnostic testing and treatment are typically fully documented.

In 2004, a new modified 5-scale system for classification of postoperative complications **(Table 2)** was suggested. Although it was based on the therapy procedure needed to manage the postoperative complication, it was the same as the original classification. The letter "d" for disability can be added to the surgical grade of the complications if needed in this new 5-scale classification in order to code for a sequela that develops after surgery.[19]

B. Outcome and classification of pancreatic fistula according to the definition and grading of pancreatic fistula (ISGPF):

The International Study Group of Pancreatic Fistula (ISGPF) published a definition and grading system for postoperative pancreatic fistula in 2005. Then, the ISGPF updated this definition and included additional standards in 2016 with an end result of division of postoperative pancreatic fistulae (POPF) into 2 groups: clinically irrelevant fistula or biochemical leak (BL) & clinically relevant fistula that requires further management (POFP B & C) **(Fig. 2).**[20]

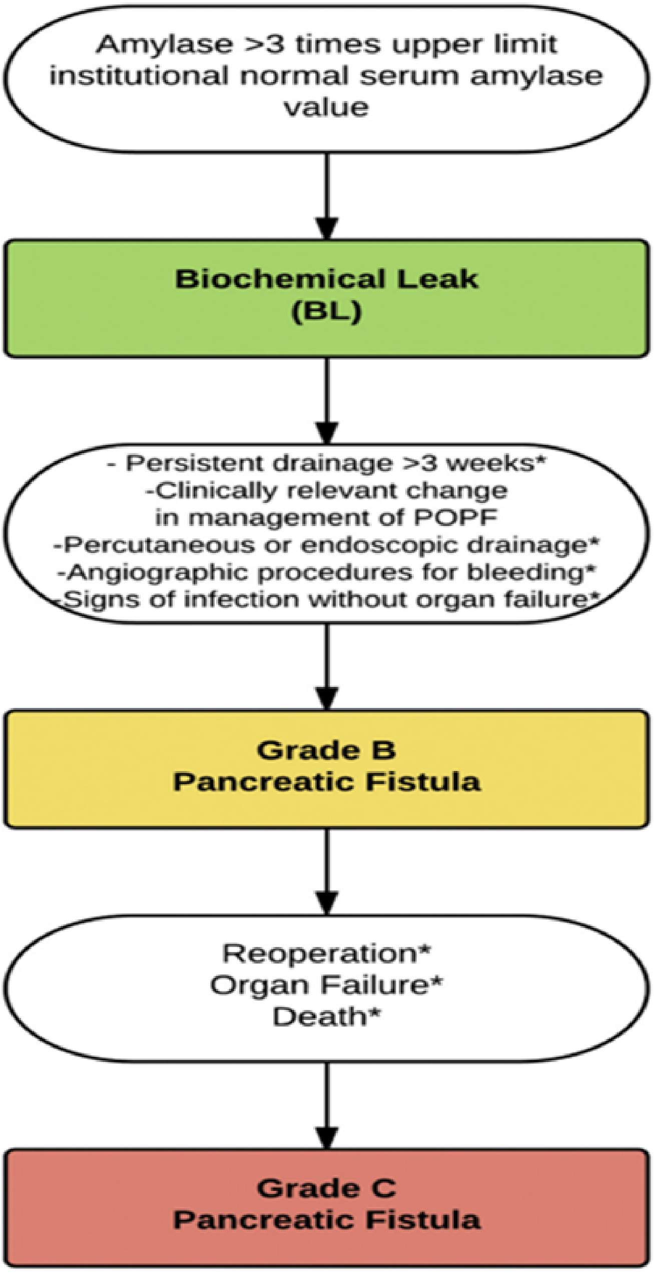

Fig 2: Flow chart for BL and POPF grade definition. BL, Biochemical leak; POPF, postoperative pancreatic fistula.[9]

C. Length of hospital stay (days)

D. Discharge with drain

Statistical analysis

The SPSS software (v.20, IBM, New York, USA) was used for statistical analysis. Fisher's exact or Chi-square tests were used for categorical variables, and the Mann-Whitney U test was used for continuous non-normally distributed data to compare the two patient groups. A stepwise variable selection process was used to generate multivariate models (inclusion: p-value of the score test ≤ 0.05, exclusion: p-value of the likelihood ratio test > 0.1). The odds ratio (OR) with a 95% confidence interval (CI), and the likelihood ratio test's p-value are used to present the results. When P values were less than 0.05, statistical results were considered significant.

Results

From December 2017 to December 2022, one thousand & six hundreds seventy-two (1672) patients underwent open splenectomy whether elective or emergent & admitted to our department of surgery, King Abdul-Aziz specialized hospital (KAASH) at Taif, Ministry of health (MOH), Saudi Arabia.

As shown in **(Table 3),** patients were subdivided into two groups; the first group (POPF/BL) involved patients who developed post operative pancreatic fistula (POPF) or just leak (biochemical leak, BL) & the second group (Non-POPF/BL) involved those did not develop BL or POPF. The total number of patients at the POPF/BL group was 214 representing 12.8%, while that of non-POPF/BL group was 1458 representing 87.2% of all patients included in this study.

the mean age of patients with POPF/BL was 49.6 ± 19.2 years with a range of 28-72 years. While the mean age of non-POPF/BL group was 43.8 ± 14.7 with a range of 13-76 years.

In both POPF/BL & non-POPF/BL groups, the male gender was the predominant representing 72.9% & 61.6% respectively.

The mean body mass indices (BMI) in POPF/BL & non-POPF/BL groups were 26.8 ± 4.3 kg/m2 & 25.1 ± 6.6 kg/m2 respectively with BMI > 25 representing 56.6% of the POPF/BL group & 52.9% of the non-POPF/BL group.

In the POPF/BL group, 36.4% of patients were smokers either cigarette or shisha, while 33.1% of patients in the non-POPF/BL group were smokers.

Only 3 patients (1.4%) in POPF/BL group were alcoholic, while in the non-POPF/BL group, 24 (1.6%) patients were consuming alcohol.

In the POPF/BL group, 17 (7.9%) patients were diabetics, and 61 (28.4%) cases were suffering from arterial hypertension. While in the non-POPF/BL group, 169 (11.6%) patients were diabetics & 506 (34.7%) were hypertensives.

The most common ASA physical status in both POPF/BL & non-POPF/BL groups was ASA 2 representing 49.5% & 49.7% respectively, while the least common ASA status in both groups was ASA 4 in only 3.3% & 2.1% of patients respectively.

Regarding the indications of splenectomy, the most common primary indication in the POPF/BL group was splenic abscess in 28 (13.1%) patients, while the commonest secondary indication in this group was post traumatic splenic injury in 67 (31.3%) patients. This is similar to the non-POPF/BL group in which the post traumatic splenic injury was the commonest secondary indication in 566 (38.8%) patients. While the commonest primary indications in the non-POPF/BL group were the primary splenic mass & Immune thrombocytopenic purpura (ITP) that represented 9.8% & 9.5% respectively.

Statistically significant differences were found in some splenectomy indications such as splenic abscess, splenic rupture, gastric carcinoma & left colon carcinoma (P value < 0.05).

Regarding the operative data of the patients, it was found that 49 (22.9%) & 188 (12.9%) patients had history of previous abdominal surgical interventions in the POPF/BL & non-POPF/BL groups respectively.

Also, most of splenectomy procedures were done at daytime in both groups (62.1% of the POPF/BL group & 63% of the non-POPF/BL one).

Most patients of the POPF/BL group were admitted to OR as emergent cases (57%), while in non-POPF/BL group, most patients were admitted as elective cases (46%).

In the POPF/BL group, full splenectomy was achieved in 100% of patients, while in the non-POPF/BL group, 121 (8.3%) patients underwent partial splenectomies.

Regarding duration of splenectomy procedure, it was noted that it was longer in the POPF/BL group with a mean of 291.7 ± 147.1 minutes & a range of 87-316 minutes. While in the non-POPF/BL group, the mean was 212.2 ± 104.8 minutes & the range was 48-287 minutes. No statistically significant difference was detected regarding the duration of surgery in this study.

The mean weight of spleen specimens was 386.2 ± 671.3 gm in the POPF/BL group & 284.3 ± 612.1 gm in the non-POPF/BL group.

intraoperative bleeding was the most frequent intraoperative complication that occurred in 92 patients (18.6% of intraoperative complications) of which 39 patients developed POPF.

A statistically significant difference was detected regarding the intraoperative complications that occurred during splenectomy procedures (P value = 0.032) being more in the POPF/BL group that occurred in 167 (78%) patients of this group.

Also, A statistically significant difference was found regarding the hospital stay being longer in the POPF/BL group (P value = 0.001) with a mean of 42.6 ± 27.1 days & a range of 8-107 days. The mean hospital stay of the non-POPF/BL group was 27.4 ± 18.9 days with a range of 5-42 days.

There were only 24 (11.2%) patients that were discharged from the hospital with a drain and all of them were of the POPF/BL group.

A statistically significant difference was found regarding the variant of discharge (P value = 0.012).

Using a binary logistic regression model, risk factors for POPF/BL following splenectomy were discovered. Indication for splenectomy (primary vs secondary), GI malignancy as secondary splenectomy indication, intraoperative complications & length of hospital stay were identified in the univariate analysis. But the multivariate analysis validated the primary vs secondary splenectomy indication, GI malignancy as a secondary splenectomy indication, and length of hospital stay as independent risk factors for the occurrence of postoperative POPF/BL after adjusting for potential confounders **(Table 4).**

Post splenectomy complications other than pancreatic fistula (POPF) were classified according to the modified Clavien-Dindo I-V classification as follows: **(Table 5)**

As shown in table (5), 484 (28.9%) patients of the 1672 patients developed various post splenectomy complications other than POPF. The most common complication was thrombocytosis and leukocytosis (peaks 7th-14th day) that occurred in 137 patients representing 28.3% of the 484 patients who developed post operative complications. While the least common complication was Overwhelming postoperative infection (OPSI) +/- disseminated intravascular coagulation (DIC) that occurred in only 2 (0.4%) patients.

Regarding the Clavien-Dindo grades, the most common grade was found grade I involving 238 (49.2%) patients with post splenectomy complications. While the least common grade was grade IVb that included only 4 patients (0.8%) that were admitted to ICU with multiorgan failure & recovered.

The Clavien-Dindo grade II included 199 (41.1%) patients; 58 patients who received aspirin due to thrombocytosis, 103 patients who received specific antibiotic regimen whether for different infections e.g., wound, chest infections or subphrenic abscess, 8 patients who received blood product transfusions post operative haemorrhage & 30 patients who received anticoagulants for post splenectomy thrombosis e.g., Spleno-portal thrombosis, Deep vein thrombosis (DVT) or Pulmonary embolism (PE).

Whereas the Clavien-Dindo grade IIIa involved 19 (3.9%) patients who were indicated for any intervention under local anaesthesia including 7 patients who underwent aspiration & chest tube insertion for post operative pleural effusion & 12 patients who underwent aspiration & pigtail insertion for large subphrenic abscesses.

The the Clavien-Dindo grade IIIb included 10 (2.1%) patients who were indicated for any intervention under general anaesthesia involving 7 patients who underwent re-operation for exploration of persistent post operative bleeding & 3 patients who were not cooperative & needed general anaesthesia for aspiration & pigtail insertion for large subphrenic abscesses.

The Clavien-Dindo grade IVa involved 9 patients who were admitted to ICU with single organ failure.

Finally, the Clavien-Dindo grade V included involved 5 (1%) patients that represented the mortality cases; 2 cases died due to severe post operative sepsis including one patient with severe pneumonia & the other with overwhelming postoperative infection (OPSI), another 2 patients died due to multiorgan failure after re-laparotomy for post operative extensive bleeding & the last patient died due to extensive post operative Pulmonary embolism (PE).

After the incidence and risk variables for post splenectomy POPF/BL had been developed, further dividing of the POPF/BL cohort into BL and clinically significant POPF of grade B/C was done & analyzed **(Tables 6,7)** & **(Fig. 3).**

The previous two tables show that biochemical leak (BL) or formerly grade A POPF was the most common grade including 124 (7.4%) patients of the 1672 patients who were included in this study with only increased amylase level in the drain > 3 times upper limit normal serum value & stopped spontaneously within 3 weeks with conservative management with/without the aid of octreotide administration.

Grade B POPF involved 68 (4.1%) patients who all developed persistent peripancreatic drainage > 3 weeks with clinically relevant change in management of POPF. Twenty-one of the 68 patients developed Signs of infection related to POPF without organ failure & improved with IV antibiotics after culture

& sensitivity test, whereas 34 patients needed percutaneous aspiration or drainage of collection that was not well drained by the previously inserted operative drain. Also, 9 patients underwent ERCP with/without pancreatic stenting with 3 patients of these 9 cases were alcoholic & discovered to have chronic pancreatitis post operatively with pancreatic duct strictures. Another 4 patients of the 68 underwent Angioembolization for POPF related bleeding.

Grade C POPF included 22 (1.3%) patients; 9 patients underwent surgical re-exploration with adequate external drainage for retained intra-abdominal infected pancreatic collections, 11 patients developed one or multiorgan failure related to the POPF & admitted to ICU then recovered & 2 patients died post re-laparotomy due to severe sepsis.

The total BL rate was 7.4%, whereas the overall POPF rate was 5.4%. BL was observed in 124 patients; 32 (25.8%) cases after primary splenectomies, and 92 (74.2%) cases after secondary splenectomies. POPF of grade B/C (clinically relevant) occurred in 90 cases including:

- 68 patients (4.1%) had grade B POPF; 26 cases post-primary splenectomies & 42 cases post-secondary splenectomies.
- 22 patients (1.3%) had grade C POPF; 6 cases post-primary splenectomies & 16 cases post-secondary splenectomies

Collectively, BL occurred in 4.6% post-primary splenectomies and 9.5% of post-secondary splenectomies, and grade B POPF occurred in 3.7% of post-primary splenectomies and 4.3% of post-secondary splenectomies patients, while grade C POPF was noted in 0.85% of post-primary splenectomies and 1.7% of post-secondary splenectomies patients.

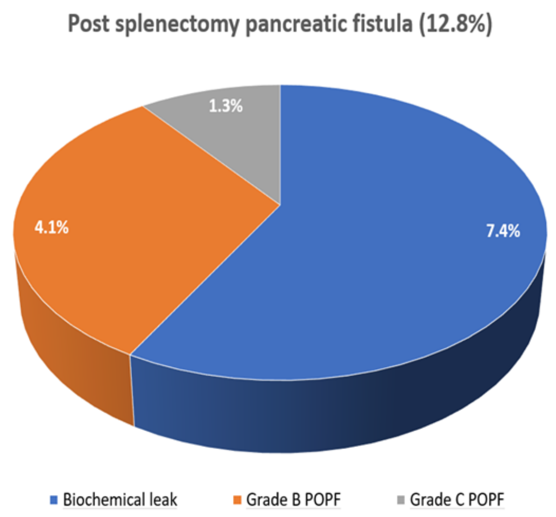

Fig 3: Pie chart showed percentages of various grades of post splenectomy pancreatic fistula (POPF) according to the definition and grading of pancreatic fistula (ISGPF).

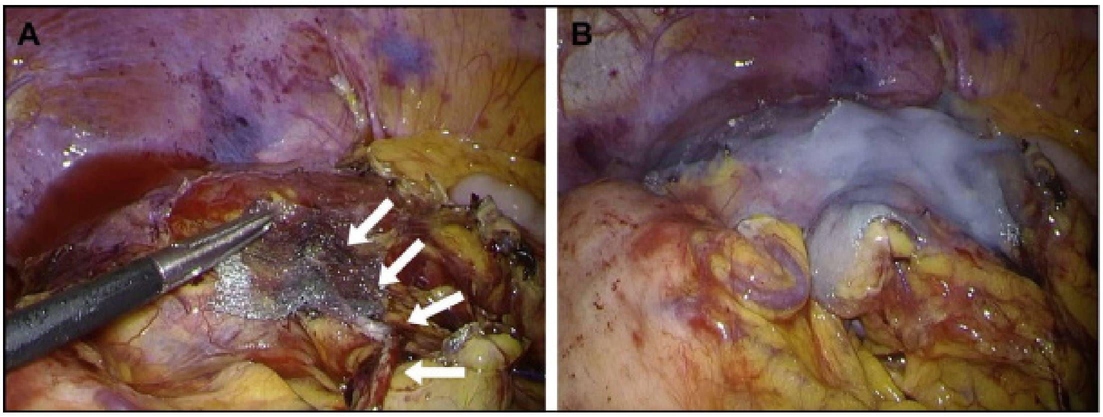

Fig 4: Laparoscopic splenectomy with a sealing system: intraperitoneal images. (A) On the staple line, polyglycolic acid felt containing dropped fibrinogen is placed. Arrows show where the staple line is. (B) The staple line and the area of dissection around the pancreas were sealed in with fibrin glue and the PGA.[46]

Table 1: The latest version of the American Society of Anesthesiologists (ASA) physical status classification system (ASAPS).[15]

ASA score	Physical status
1	Physically normal healthy patient that is fit, non-obese (BMI < 30), a non-smoker with good tolerance to exercise
2	patient with mild systemic disease e.g., patient without any functional limitations and well-controlled disease (e.g., treated hypertension (HTN), obesity with BMI < 35, frequent social drinker, or cigarette smoker).
3	patient with a severe systemic disease which is not life-threatening. E.g., patient with some functional limitations due to disease (e.g., poorly treated HTN or DM, morbid obesity, chronic renal failure, a bronchospastic disease with intermittent exacerbation, stable angina, implanted pacemaker).
4	patient with a severe systemic disease that is a constant threat to life e.g., patient with functional limitations from severe, life-threatening disease (e.g., poorly controlled COPD, unstable angina, symptomatic CHF, recent (less than three months ago) myocardial infarction or stroke
5	A moribund patient who is not expected to survive without the operation. The patient is not expected to survive beyond the next 24 hours without surgery e.g., ruptured abdominal aortic aneurysm, massive trauma, and extensive intracranial hemorrhage with mass effect.
6	A brain-dead patient whose organs are being removed with the intention of transplanting them into another patient.

The addition of "E" to the ASAPS (e.g., ASA 2E) denotes an emergency surgical procedure. The ASA defines an emergency as existing "when the delay in treatment of the patient would lead to a significant increase in the threat to life or body part."

Table 2: Modified 5-scale Clavien–Dindo scoring system of postoperative complications.[8]

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions Allowed therapeutic regimens are drugs as antiemetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside.
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included
Grade III • **IIIa** • **IIIb**	Requiring surgical, endoscopic, or radiological intervention • Intervention not under general anesthesia • Intervention under general anesthesia
Grade IV • **IVa** • **IVb**	Life-threatening complication (including CNS complications)* requiring IC/ICU-management • single organ dysfunction (including dialysis) • Multiorgan dysfunction
Grade V	Death of a patient
suffix ("d" for disability)	This suffix indicates that a follow-up is required to comprehensively evaluate the outcome and related long-term quality of life

brain hemorrhage, ischemic stroke, subarachnoid bleeding, but excluding transient ischemic attacks (TIA); IC: Intermediate care; ICU: Intensive care unit.

Table 3: Demographic data of the patients

	POPF/BL	Non-POPF/BL	P value
Total number of patients (%)	214 (12.8%)	1458 (87.2%)	
Age (year)			
• Mean ± SD	49.6 ± 19.2	43.8 ± 14.7	0.38
• Range (years)	28-72	13-76	
Sex			
• Male (%)	156 (72.9%)	898 (61.6%)	0.66
• Female (%)	58 (27.1%)	560 (38.4%)	
BMI (kg/m2)			
• Mean ± SD	26.8 ± 4.3	25.1 ± 6.6	0.84
• < 25 (%)	93 (43.4%)	687 (47.1%)	
• > 25 (%)	121 (56.6%)	771 (52.9%)	
Smoking			
• No (%)	136 (63.6%)	975 (66.9%)	0.59
• Yes (%)	78 (36.4%)	483 (33.1%)	
Alcohol consumption			
• No (%)	211 (98.6%)	1434 (98.4%)	1.02
• Yes (%)	3 (1.4%)	24 (1.6%)	
Diabetes mellitus			
• No (%)	197 (92.1%)	1289 (88.4%)	0.96
• Yes (%)	17 (7.9%)	169 (11.6%)	
hypertension			
• No (%)	153 (71.6%)	952 (65.3%)	0.77
• Yes (%)	61 (28.4%)	506 (34.7%)	
ASA classification			
• Mean ± SD	2.7 ± 0.6	2.1 ± 0.8	0.41
• 1 (%)	64 (29.9%)	447 (30.6%)	
• 2 (%)	106 (49.5%)	724 (49.7%)	
• 3 (%)	37 (17.3%)	256 (17.6%)	
• 4 (%)	7 (3.3%)	31 (2.1%)	
Indications for splenectomy			
Primary (n=703)	71 (33.2%)	632 (43.4%)	
•1ry splenic mass	6 (2.8%)	142 (9.8%)	1.01
•Splenic cyst	0 (0%)	57 (3.9%)	0.13
•Splenic abscess	28 (13.1%)	39 (2.7%)	0.021
•Splenic rupture	23 (10.7%)	36 (2.5%)	0.012
•ITP	4 (1.9%)	139 (9.5%)	0.99
•Lymphoma	8 (3.8%)	92 (6.3%)	0.76
•Splenic infarction	2 (0.9)	127 (8.7%)	0.52
Secondary (n= 969)	143 (66.8%)	826 (56.6%)	
• post-traumatic	67 (31.3%)	566 (38.8%)	0.41
• Gastric carcinoma	31 (14.4%)	29 (2%)	0.011
• Splenic artery aneurysm	0 (0%)	5 (0.3%)	0.78
• Hypersplenism in PTH	16 (7.5%)	188 (12.9%)	0.93
• Left colon carcinoma	29 (13.6%)	38 (2.6%)	0.013
Previous abdominal surgery			
• No (%)	165 (77.1%)	1270 (87.1%)	0.53
• Yes (%)	49 (22.9%)	188 (12.9%)	

	POPF/BL	Non-POPF/BL	P value
Urgency of surgery • Emergency (%) • Delayed (%) • Elective (%)	122 (57%) 17 (7.9%) 75 (35.1%)	649 (44.5%) 139 (9.5%) 670 (46%)	0.61
Time of surgery • daytime (%) • Nighttime (%)	133 (62.1%) 81 (37.9%)	918 (63%) 540 (37%)	0.59
Extent of splenectomy • Full (%) • Partial (%)	214 (100%) 0 (0%)	1337 (91.7%) 121 (8.3%)	0.39
Duration of surgery (min) • Mean ± SD • Range (min)	291.7 ± 147.1 87-316	212.2 ± 104.8 48-287	0.087
Weight of spleen (gm) • Mean ± SD	386.2 ± 671.3	284.3 ± 612.1	0.42
Intraoperative complications • No (%) • Yes (%)	47 (22%) 167 (78%)	1134 (77.8%) 324 (22.2%)	0.032
Length of hospital stay (days) • Mean ± SD • Range (days)	42.6 ± 27.1 8-107	27.4 ± 18.9 5-42	0.001
Discharge with drain (%)	24 (11.2%)	0	0.012

Table 4: Binary logistic regression model for predictors of the development of a POPF/BL after splenectomy (POPF/BL vs non-POPF/BL) for only statistically significant difference parameters in the univariate analysis

Parameters	Univariate OR (95% CI)	P value	Multivariate OR (95% CI)	P value
Indication for splenectomy (primary vs secondary)	0.294 (0.131–0.712)	0.021	0.432 (0.254–0.812)	0.006
GI malignancy	0.543 (0.199–0.877)	0.016	0.587 (0.212–0.956)	0.041
Intraoperative complications	0.696 (0.772–0.918)	0.032	0.889 (0.692–0.999)	0.17
Length of hospital stay (days)	0.773 (0.543–0.819)	0.001	0.761 (0.706–0.913)	0.027

Table 5: Postoperative complications post splenectomy (other than POPF) according to modified Clavien-Dindo I-V classification

	Grade **I**	Grade **II**	Grade **IIIa**	Grade **IIIb**	Grade **IVa**	Grade **IVb**	Grade **V**	**Nº=484 (28.9%)**	**%**
Thrombocytosis and leukocytosis (peaks 7th-14th day)	79	58						137	28.3%
Sympathetic pleural effusion	96		7					103	21.3%
Wound infection	51	33						84	17.4%
pulmonary atelectasis and pneumonia		57			6	2	1	66	13.6%
Post operative bleeding	12	8		7	2		2	31	6.4%
Subphrenic abscess		13	12	3				28	5.8%
Spleno-portal thrombosis (fever, abdominal complaints)		19						19	3.9%
Deep vein thrombosis (DVT)		11						11	2.3%
Pulmonary embolism (PE)					1	1	1	3	0.6%
Overwhelming postoperative infection (OPSI) +/- disseminated intravascular coagulation (DIC)						1	1	2	0.4%
	238 (49.2%)	199 (41.1%)	19 (3.9%)	10 (2.1%)	9 (1.9%)	4 (0.8%)	5 (1%)	484 (100%)	

Table 6: Outcome and classification of pancreatic fistula according to the definition and grading of pancreatic fistula (ISGPF)

	BL (formerly Grade A POPF)	**Grade B POPF**	**Grade C POPF**
increased amylase level in the drain > 3 times upper limit normal serum value	124		
Persisting peripancreatic drainage > 3 weeks		68	
Clinically relevant change in management of POPF		68	
Signs of infection related to POPF without organ failure		21	
Percutaneous aspiration/drainage of collection		34	
ERCP with/without pancreatic stenting		9	
Angioembolization for POPF related bleeding		4	
Re-operation for POPF			9
POPF related organ failure			11
POPF-related death			2

Table 7: Percentages of various grades of post splenectomy pancreatic fistula according to the definition and grading of pancreatic fistula (ISGPF)

	N°	Overall percentage
Total number of patients with POPF/BL	214	12.8%
BL (formerly Grade A POPF)	124	7.4%
Grade B POPF	68	4.1%
Grade C POPF	22	1.3%

Table 8: Post operative complications of splenectomy[3]

Acute	Short term	Long term
• Hemorrhage • Pulmonary atelectasis and pneumonia • Sympathetic pleural effusion • Subphrenic abscess/cellulitis • Gastric ileus • Acute pancreatitis • Thrombocytosis and leukocytosis (peaks 7th-14th day) • Severe thrombosis after splenectomy for myeloproliferative disorders	• Overwhelming postoperative infection (OPSI) ± disseminated intravascular coagulation (DIC) • Pulmonary infection • Deep vein thrombosis (DVT) • Spleno-portal thrombosis (fever, abdominal complaints)	• OPSI ± DIC • Pulmonary infection • Venous thrombosis • Pulmonary hypertension • Enhanced atherosclerosis • Arterial thrombosis

Table 9: Difference in postoperative pancreatic fistula definition between ISGPS 2005 and 2016.[9]

	Biochemical leak	Grade A	Grade B	Grade C
2005 POPF definition	-	Drain amylase > 3 times upper limit from institutional normal serum amylase level	• Discharge with drainin place • Clinically relevant change in management of POPF • Percutaneous or endoscopic drainage • Extended hospital stay or re-admission • Signs of infection	• Re-operation • ICU admission • Death
2016 POPF definition	Drain amylase > 3 times upper limit from institutional normal serum amylase level	-	• Persistent drainage > 21 days • Clinically relevant change in management of POPF • Percutaneous or endoscopic drainage • Angiographic procedures for bleeding • Signs of infection without organ failure	• Re-operation • ICU admission • Death

Discussion

For both ancient medical personnel and philosophers, the spleen was a mystery. In his description of the spleen as a mysterious organ, Galen postulated that it purified blood and liver material before returning it to the stomach after being removed from both. Even though Aristotle noticed that the asplenic state is compatible with life, its complicated function and anatomy remain a major field for scientific & medical research.[21]

It is widely known that the spleen is the body's largest lymphoid organ. Yet unlike lymph nodes, the spleen is connected to the systemic circulation and does not receive drainage from the lymphatic system.[22]

Therefore, it is obvious that the spleen performs crucial hematological and immunological roles.[23]

Concerning hematological function, a healthy spleen may play a significant role in the destruction of aberrant blood cells in disorders including hereditary spherocytosis, autoimmune anemia, neutropenia, and thrombocytopenia. Hypersplenism and symptomatic splenomegaly are the two main disorders caused by an abnormal or malfunctioning spleen. Anemia, neutropenia, and/or thrombocytopenia that develop individually or together as a consequence of splenic enlargement due to any cause are referred to as hypersplenism. Confirmation of diagnosis can be established by the recovery of cytopenia post-splenectomy.[24]

The most frequent causes of symptomatic splenomegaly are lymphoproliferative and myeloproliferative diseases. higher metabolism may result in reduced body weight, fever, excessive sweating, and vague pain at the left upper quadrant resulting from decreased blood supply and consequent splenic infarction.[25]

The spleen is just one among several organs, including the liver & lymph nodes, that have an immunologic role and offer the body immune defense, so the immunologic functions of the spleen are in common with these other organs involved in the body immunity. Despite of this, spleen performs a number of unique immunologic functions by itself e.g., compared to the liver, the spleen is more efficient at eliminating the non-opsonized bacteria, which are primarily encapsulated organisms. It is where most immunoglobulin-M antibodies are made, so after splenectomy, serum immunoglobulin-M levels have been found to drastically decline. Also, the primary site for the synthesis of the opsonins tuftsin and properdin is the spleen. Serum tuftsin levels have been reported to decline post splenectomy, and in situations leading to functional asplenia, tuftsin deficiency may occur before overt hyposplenism. The asplenic condition is associated with immunologic consequences due to the specificity of splenic function and the inability of other organs to cover its unique functions.[26]

Despite the spleen's significant physiological importance, splenectomy had been practiced for many years before the physiology and function of the spleen were understood. The first recorded splenectomy was carried out in 1549 to remove an oversized spleen with symptoms.[1]

Universally, the incidence of splenectomy is around 6.4–7.1 per 100,000 individuals per year, with trauma (25%) and hematological diseases (25%) being the main causes.[27]

Except when performed for massive splenomegaly, open splenectomy (OS) is typically not a technically challenging surgery. However, it necessitates a laparotomy through a subcostal or a lengthy midline incision.[28]

Laparoscopic splenectomy is now the preferred method for managing many hematological disorders when splenectomy is essential, but risks and complications have been recorded during and after this procedure. Due to incomplete mention in literature papers, the prevalence of intraoperative complications is uncertain. When the reasons for converting from laparoscopic to open splenectomy are investigated, it becomes clear that intra-operative bleeding, which accounts for 80% of indications for conversion, is the most frequent issue.[29]

Splenectomy is routinely carried out for a variety of causes e.g., trauma and other pathological illnesses. Although patients with many types of hematologic diseases can potentially benefit from splenectomy, blunt abdominal trauma is still the most prevalent cause for this procedure. Additionally, splenectomy is done for diagnostic purposes, to treat hypersplenism or splenomegaly, and in cases of iatrogenic injury and involvement by nearby disease processes.[26]

Splenectomy indications might be either absolute or relative. Absolute indications include the following: 3

- Splenic rupture that could be attributable to trauma or spontaneous, as in tropical splenomegaly.
- Excision of splenic cysts.
- Treatment for splenic abscesses since all the organ is often get damaged, such as by tuberculosis.
- **Neoplasms:**

► As part of the drastic surgical oncological excision of a nearby tumor, such as a locally advanced pancreatic, gastric, or colorectal cancer.

► Angiomas.

► Primary (rare).

- Splenic artery aneurysms.

Hypersplenism, symptomatic splenomegaly, and the spleen's destruction of aberrant blood cells are some of the relative indications for splenectomy. Patients with hemolytic anemia (Such as those with hereditary spherocytosis [HS] and autoimmune hemolytic anemia) undergo splenectomy because splenic macrophages prematurely destroy red blood cells that are intrinsically abnormal, or antibody coated. Although none of these diseases may be completely cured after splenectomy, it frequently seems to be the therapy of choice since it can reduce the underlying anemia. Before performing a splenectomy on hematological patients, two matters must be established; First, it must be demonstrated that the spleen is the location of excessive red cell destruction through bone marrow biopsy, peripheral blood, and isotope assays to demonstrate excessive uptake in the spleen. Secondly, the ability of the bone marrow to generate enough new cells in the absence of the spleen to correct cytopenia must also be demonstrated. Otherwise, cytopenia cannot be reversed and the patient's condition would only get worse.[21]

When splenectomy is performed for hematological diseases, a thorough search for accessory spleens should also be conducted.[24]

A more non-operative strategy has been adopted due to the long-term thromboembolic risk that is higher in hematological diseases related to continuous hemolysis, especially thalassemia intermedia.30 Patients with ITP, in contrast, seem to be less likely to suffer from postoperative complications after splenectomy, maintaining its position as the second-line therapy with the greatest promise for cure and safety. However, a splenectomy-sparing approach for ITP is also emerging, and recent guidelines advise delaying splenectomy for 12 months after ITP diagnosis to give enough time for a potential remission.[31]

An overall complication rate of 5 to 60% is caused by the spleen's substantial blood supply, anatomic relationship to important intra-abdominal organs, and the forceful traction and maneuvers required for its exposure. The majority of OS complications are caused by hemorrhage, pancreatic tail injury, or lung causes. OS for malignancy or splenomegaly may be accompanied with 40-60% morbidity.[28]

Spleen is a soft organ that is readily injured during mobilization with splenic hilar vessels that are delicate and can be injured during surgical manipulations. So, the splenic parenchyma or capsule may lacerate, causing bleeding from the spleen,[32] with retractors, instruments, insufficient ligation or dealing with splenic vessels.[33] The splenic capsule may become more susceptible to rupture in individuals who have received steroids for a long period of time. To prevent splenic hemorrhage, the instruments used to retract the spleen must be handled carefully & delicately.[28]

The left gastroepiploic artery, the short gastric vessels, small vessels in the retroperitoneal connections of the spleen, the vessels along the pancreatic tail & the inconsistent arterial blood supply of the lower pole of the spleen are additional causes of intraoperative bleeding during splenectomy. Splenectomy is a complicated procedure that calls for the surgeon to be skilled at dissecting intricate tissue planes and knowledgeable in controlling blood vessels. Bipolar diathermy or ultrasonic shearing can be used to coagulate the short gastric vessels, but it's important to avoid getting the energy source in proximity to the nearby stomach.[34]

Rarely, during splenectomy, surrounding organs may be injured intraoperatively such as injuries to the stomach & colon caused by thermal damage during the dissection and control of the short gastric blood vessels. Careful usage of energy sources is necessary during dissection close to the colon and stomach to prevent injuries. The pancreatic tail can also be injured intra-operatively from either direct trauma or via devascularization of the pancreatic tail, which is more likely to happen if the organ is adjacent to the splenic hilum. identification of the pancreatic tail can be feasible during procedure and its separation from the spleen sufficiently to control the hilar arteries without disrupting the pancreas.[28]

Other intraoperative hematological complications include splenosis, which results from the auto transplantation of splenic tissue during surgical manipulation of the spleen, and failure to remove accessory spleens with persistent thrombocytopenia. Splenunculi, or small splenic implants, spread & grow along the peritoneal surfaces of the abdomen. Although splenosis implants are mostly asymptomatic, they can manifest as abdominal pain, a mass or bowel obstruction. Additionally, the hematological diseases for which the patient had a splenectomy might recur. therefore, in order to exclude the presence of accessory spleens, the splenic hilum, gastrosplenic omentum, gastrocolic ligament, and area along the pancreas tail should be carefully examined. Also, care must be given at all times while manipulating the spleen to prevent capsular disruption, which can cause splenosis and recurring hematological disorder.[28]

The post splenectomy complications **(Table 8)** can be categorized into acute, short, and long term.[3]

Reactive bleeding from the diaphragm and posterior abdominal wall's small vessels can occur post splenectomy. Therefore, thorough hemostasis is required to avoid the emergence of a sizable haematoma that could later become infected. Depending on the patient's physical condition and the condition for which splenectomy was conducted, operative mortality ranges from 3 to 15%.[21] Mortality is particularly high (30%) after splenectomy that is performed for myeloproliferative diseases (Such as myelofibrosis and chronic granulocytic leukemia). This higher rates of morbidity and mortality are because of hemorrhage. There have been reported that platelets have functional defects in the myeloproliferative diseases, which represent a subset of the malignant population. So, before splenectomy in this group, the platelet function or bleeding time should be evaluated, and the likelihood of platelet transfusion despite a normal platelet count should be taken into consideration.[35]

Up to 10% of individuals who have splenectomy for hematological disorders experience thromboembolic consequences, which can vary from deep vein thrombosis (DVT) and pulmonary embolism (PE) to portal vein thrombosis (PVT). Splenic & portal vein thrombosis, which manifests as fever and pain in the abdomen, is a worrying side effect following splenectomy with 10% mortality rate.[36] Deep vein thrombosis (DVT) or pulmonary embolism must also be taken into consideration as a cause of postoperative fever given the increased platelet count following splenectomy, which reaches its peak by the 10th day. Although they could be the precursor to a serious pulmonary embolism, DVT and minimal pulmonary embolism may both otherwise go undetected.[37]

Subphrenic abscess is uncommon. It could develop as a result of an infected hematoma or an infection after colonic or gastric injury. Subphrenic abscesses are common in steroid-using patients with autoimmune diseases, such as immune thrombocytopenic purpura (ITP), and are often treated with an antibiotic course.[35]

Hodgkin's lymphoma and chronic lymphocytic leukemia are two malignant lymphoproliferative diseases that have a significant morbidity from infectious consequences, particularly bronchitis and pneumonia.[38]

The overwhelming post-splenectomy infection (OPSI) is the main long-term threat following splenectomy. After trauma, OPSI has a lifetime risk of 0.1-0.5% & a rate of mortality up to 50%. As cases of fulminant infection have been documented more than 20 years after splenectomy and are more common with encapsulated organisms such as streptococcus pneumonia, Neisseria meningitides, and H influenza, the risk of infection is lifelong. The most prevalent infection is pneumococcal infection that has up to 60% mortality rate. Despite being significantly less frequent, H. influenza type B infection is nevertheless serious, especially in children. The risk of OPSI is higher within the first three years following splenectomy. more in children particularly those < five years & who had splenectomy for trauma (>10% extra risk). Immunosuppressed or immunodeficient patients are more susceptible to infection by encapsulated organisms (HIV, myeloma, leukemia, etc.).[3]

It is unknown if splenectomy raises the risk of getting cancer. Splenectomy has been associated with a considerable rise in the induction of malignant tumors in both rat and mouse models, as well as a reduction in the number of peripheral blood lymphocytes after tumor inoculation in a mouse model. Splenectomy has been associated but not always in some epidemiological research, with an elevated chance of getting cancer. The failure of these studies to exclude patients who had malignancies prior to splenectomy is an important defect in their studies.[39]

Injury of the pancreas is one of the most serious and significant postoperative complications of splenectomy with an incidence of just 1%-2%.40 Nevertheless, research on POPF development post splenectomy has been conducted, but the subject is still somewhat neglected.[13]

Even though the surgical technique used during splenectomy is mostly standardized, pancreatic tail injuries can nevertheless occur, particularly during splenic hilum dissection and ligation.[14]

Pancreatic fistula can arise in communication with the skin externally or, less frequently, internally with the abdominal organs or peritoneal space when the pancreatic duct or one of its branches gets injured due to trauma or inflammation. A fistula can result in pancreatic fluid loss and electrolyte imbalance, hemorrhage, malabsorption, respiratory complications, skin disintegration, and autodigestion or erosion of nearby viscera. Mortality rates are between 8% and 10%, with sepsis and hemorrhage being the two main causes of death. On the 3rd and 4th postoperative days, collection is most frequently seen. The most typical sign is fluid with high amylase level.[40]

The International Study Group of Pancreatic Fistula (ISGPF), a group of 37 pancreatic surgeons from every inhabited continent, met in 2005 to provide a widely approved & objective definition of postoperative pancreatic fistula (POPF). There were 26 different definitions of a POPF at that time, making it impossible to compare outcomes among surgeons and clinical centers because each study's authors had a different definition of what considered a POPF. Before this classification, there had never been a POPF classification that had gained international acceptance. The ISGPF review of literature described POPF as an abnormal connection between the epithelium of the pancreatic duct and another epithelial surface that contains fluid rich in pancreatic enzymes.9 This classification describes the grade A leakage of these fistulas as asymptomatic, transient, and only detectable through laboratory tests of amylase levels. Grade B leakage may necessitate further medical interventions, such as percutaneous drainage, antimicrobial therapy, more nutrition, and somatostatin analogs. The most severe type of fistula, grade C, necessitates major therapeutic interventions. Thus, a grade C fistula might need intervention by surgery for effective care, otherwise it may result in septicemia, organ failure, or even death.[41]

In 2017, an update for the definition and grading of pancreatic fistula (ISGPF) was announced in Surgery.[42]

Some modest but significant changes have been applied to the previously validated classification in this updated one in order to clarify and extend it **(Table 9).** First, the former "grade A POPF" is now known as biochemical leak (BL). The goal is to prevent the perceived meaning that this condition is a "fistula," as it's of no clinical significance. Because the original classification of POPF could be used to refer to either the overall occurrence of all grades of POPFs (Grades A, B, and C) or only to those having a clinical affect (Only grades B and C), this update will allow for a better and clearer identification of what refers to by the "fistula rate" of an operative series. The second significant revision in the POPF grading system is related to the "grey zone" in the originally published classification of the use of radiologically interventional drainage (ID) approaches and whether the need for such procedures should shift the grade of severity from grade B to grade C POPF is the subject of the second significant revision in the POPF grading system. Because of confusion in the original definition of severity, a variety of interpretations has been suggested in the literature.[9]

According to the 2016 ISGPS updated definition, grading of postoperative pancreatic fistula fistulas includes:9

► Biochemical leak (BL= no POPF) or formerly a grade A POPF: This disorder is no longer classified as a true pancreatic fistula or a true complication and only concerns the original "grade A" POPF. The BL has no clinical significance by definition because it is referred to as a "biochemical fistula" in literature.

► Grade B POPF: This grade indicates an appropriately identified fistula with elevated amylase activity in any drain fluid associated with a clinically significant state. A grade B POPF is associated with a modification in the management plan of the predicted postoperative pathway. In contrast to the BL, pancreatic drains may need to remain in place for a longer time (three weeks or 21 days postoperatively), or they may need to be repositioned using radiologically interventional procedures to drain a retained intra-abdominal fluid collection. For the same objective, percutaneous or endoscopic ID is also recommended. Blood transfusions and/or interventional angiography are typically required in case of bleeding or pseudo-aneurysm caused by POPF. The fistula becomes a grade C POPF whenever surgical reoperation is indicated, or any organ failure takes place. In the majority of cases, leukocytosis and low-grade fever are the most prevalent signs of mild infection that occurs secondary to POPF necessitating just antibiotic regimen; however, once one or more organ failures arise, the fistula would change to a C grade POPF. Finally, if mortality occurs (for example, as a result of a serious pulmonary embolism, kidney failure, or cardiac infarction), the grade B POPF may change to a grade C if the fistula is the cause or triggering event.

► Grade C POPF: When a grade B POPF results in organ failure or clinical issues that necessitates further surgery, the POPF is upgraded to a grade C. ICU stays are frequently essential, and because of complications caused by the POPF, the hospital stay extends too much. For classification of POPF, definition of postoperative organ failure is as follows; reintubation, use of inotropes or hemodialysis is required for a period of time exceeding 24 hours due to pulmonary, heart, or kidney dysfunction respectively. Reoperations are typically done to treat fistulas after percutaneous and/or endoscopic ID procedures have failed to improve the clinical issues. Reoperation obviously has the potential to result in significant morbidity and mortality. In addition to the previously mentioned, the POPF is upgraded to a grade C POPF if a subsequent POPF-specific death occurs even without a reoperation. About one-third of grade C POPFs have one of each of these three defining circumstances, and they frequently occur simultaneously.

On the basis of the several clinical and biochemical indicators, POPF diagnosis can be predicted. The following criteria form the basis of definition: discharge of any measurable volume of drain fluid through an intraoperatively inserted drain (Or a later, percutaneous inserted drain) at or after the 3rd postoperative day, with an amylase level above three times the upper normal serum level.[43]

The most frequent clinical signs of pancreatic fistula are excessive and persistent abdominal pain, pyrexia, and incisional erythema. A routine assessment of amylase concentrations and WBC on the 1st postoperative day is advised because laboratory tests will reveal hyperamylasemia and high WBC. The amylase level of the drain discharge should be calculated for patients with abdominal drainage if the abdominal drain output is greater than anticipated or has the typical cloudy look of pancreatic juice.[44]

Any cause for worry must prompt the surgeon to request an abdominal CT to be check for peripancreatic edema or fluid collection, pancreatic necrosis, pseudocyst and subphrenic abscess.[29]

Early diagnosis, follow up & percutaneous aspiration or drainage guidance for other diagnostic tests can all be done using abdominal CT, which is considerably superior to clinical assessment and other radiographic techniques. POPF frequently manifests as retained fluid collection at the left subphrenic space, but it can also manifest as edema of the pancreatic tail, poorly defined fluid collections, an external pancreatic fistula, a subphrenic abscess, or a pancreatic pseudocyst with a well-defined capsule. The differential diagnosis should include liquefied or infected hematomas & abscesses caused by gastric or colonic injury.[10]

Many studies were performed for the purpose of intraoperative POPF prophylaxis e.g., a study done by Arnold et al. (2022)[45] in which 262 adult post traumatic splenectomies were performed between the years 2010 and 2020; 160 of these cases met the inclusion criteria and were analyzed. In 135 cases, sutures only across hilar vessels were done with 6 patients of them (4.4%) developed POPF. On the other side, Staples only were used to control hilar vessels in 13 cases with 3 patients (23%) had postoperative PF. In ten cases, sutures and staples were combined; none of these patients developed POPF by using this technique. They observed that POPF are more likely to develop when staples alone are utilized across hilar vessels, despite this finding not being statistically significant.

Also, in a study by Tsutsumi et al. (2016)46 that involved 50 patients with liver cirrhosis who underwent laparoscopic splenectomies between September 2010 and March 2014. The staple line and the area of dissection around the pancreas were sealed in with fibrin glue and the PGA felt in 27 consecutive patients (GA with fibrin group) **(Fig. 4).** With PGA felt and fibrin glue applied ex vivo, this newly described sealing technique demonstrated a strong sealing effect and outstanding clinical results. They had not encountered any PF cases following the clinical introduction of this novel technique. Also, this technique readily demonstrated efficient PF prevention, however, this study was limited only to laparoscopic splenectomy.

images. (A) On the staple line, polyglycolic acid felt containing dropped fibrinogen is placed. Arrows show where the staple line is. (B) The staple line and the area of dissection around the pancreas were sealed in with fibrin glue and the PGA.[46]

Regarding management of POPF, The patient's prognosis must be determined during the first three days because 30% of serious complications can happen within this time. Segmental pancreatitis resolves quickly and without any further complications with the aid of conservative medical treatment. More than two thirds of patients frequently respond well to replacement of fluids and nutrient therapy (total parenteral nutrition [TPN] for 4-6 weeks) for mild pancreatic injury. Without prompt antibiotic treatment, the incidence of pancreatic infection would be 40%–70%, with 30% of cases developed necrosis within one week. Imipenem or ciprofloxacin plus metronidazole are the mainstays of treatment.[40]

In 90% of patients of post-surgical pancreatitis, the abdominal pain and hyperamylasemia resolve on their own after just one week. If these symptoms persist for an extended period of time, the patient is likely suffering from ductal injury or pancreatic necrosis, both of which can result in the formation of pseudocysts. Closed suction drainage must be used to drain fluid collection for at least 4 days. Endoscopic retrograde cholangiopancreatography (ERCP) must be used to treat the patient if a fistula occurs (> 50 mL/day of amylase-rich fluid draining from the percutaneous drain), followed by CT monitoring and, if CT is negative, the drain can be removed. However, percutaneous and/or surgical draining techniques are required if the fluid collection is getting bigger. The indication for surgical closure of the fistula is when the daily output reaches 200 ml. Drainage, resuscitation with isotonic crystalloid solution, bowel rest, TPN, and correcting metabolic acidosis associated to bicarbonate losses can be used to treat the majority of low output fistula cases (< 200 mL/day). Somatostatin and its analogs, such as octreotide, can lower basal and stimulated pancreas production if administered in dosages as small as 50 µg twice a day. As a result, about 80% of external pancreatic fistula and 40%–60% of internal pancreatic fistula spontaneously stopped.[47]

An extremely uncommon complication after splenectomy is necrotizing pancreatitis requires immediate management. Mortality rate is reduced obviously after necrosectomy which is 10%–40% with necrosectomy compared to 50%–80% without necrosectomy. it can be diagnosed by appearance of non-enhanced zone within the pancreatic tissue and the peripancreatic fat after performing contrast-enhanced CT scan. US or CT-guided needle aspiration also can be done. If this diagnostic test reveals a sterile sample, It may not be essential to do a necrosectomy. There must be less than 50% necrosis. If the management of the intensive care unit (Mechanical breathing, hemofiltration, and hemodialysis) is insufficient, necrosectomy must be performed.[40]

Subphrenic abscess is somewhat frequent. The subphrenic space may get filled with serosanguinous fluid or fluid from a pancreatic fistula and develop an infection. Patients frequently have a fluctuating fever, leukocytosis, a reactive pleural effusion in the left side of chest & less commonly hiccups due to diaphragmatic irritation. Percutaneous drainage combined with effective antibiotic regimen frequently leads to complete resolution.[44]

A pancreatic injury must have occurred as a result of the patient's illness or the surgery's performance.48

Many authors have researched the primary risk factors for pancreatic injury. In 2001, Park et al.49 questioned if age, sex & other variables may be considered independent risk factors. Their initial analysis revealed that age should be taken into account as an independent factor raising the risk of complications, with the youngest and oldest patients having the highest risk.

This corresponds to what was detected in this current study in which no statistically significant difference was found regarding the age of patients in both POPF/BL & non-POPF/BL groups (P value > 0.05). In our study, the mean age of patients with POPF/BL was 49.6 ± 19.2 years, while the mean age of non-POPF/BL group was 43.8 ± 14.7 years.

In a study done by Mehdorn et al. (2022)5, the mean age of patients with POPF/BL was 52.9±17.4 years, while the mean age of non-POPF/BL group was 52.9±17.4 years. Also, no statistically significant difference was detected regarding the age of patients in both groups.

Regarding to gender, males were detected to be the predominant sex both POPF/BL & non-POPF/BL groups representing 72.9% & 61.6% respectively in this study with no statistically significant difference detected regarding to sex in both groups (P value = 0.66). This corresponds to what was reported in Mehdorn et al. (2022)5 study in which male gender represented 63.9% in the POPF/BL group & 57.8% in the non-POPF/BL group.

The upper left abdominal quadrant can be difficult to access during surgery, especially in cases when patients have splenomegaly and are obese. As a result of these conditions, unintentional intraoperative pancreatic tail injury may go undetected and complicated with POPF or BL.[48]

In this current study, the mean body mass indices (BMI) in POPF/BL & non-POPF/BL groups were 26.8 ± 4.3 kg/m2 & 25.1 ± 6.6 kg/m2 respectively with BMI > 25 representing 56.6% of the POPF/BL group & 52.9% of the non-POPF/BL group. No statistically significant difference was detected in both groups in our study (P value = 0.84).

In Mehdorn et al. (2022)5 study, the mean BMI was 25.7 ± 6.1 kg/m2 in the POPF/BL & 25.7 ± 4.9 kg/m2 in the non-POPF/BL groups with BMI > 25 representing 47.2% of the POPF/BL group & 38.4% of the non-POPF/BL group. Also, no statistically significant difference was detected in both groups (P value = 1).

On the other hand, Dominguez et al. (2007)[50] attempted to show that BMI was a risk factor, however there was no statistically significant difference between the groups with BMIs > 40 and < 40.

Although different risk factors including smoking and alcohol abuse for developing POPF are identified after pancreatic surgery, none of them were discovered to be related to POPF post splenectomy.[9]

In this study, 36.4% of patients were smokers either cigarette or shisha In the POPF/BL group, while 33.1% of the non-POPF/BL group were smokers. Also, 3 patients (1.4%) were alcoholic in POPF/BL group, while in the non-POPF/BL group, 24 (1.6%) patients were consuming alcohol. No statistically significances were detected regarding to smoking & alcohol abuse in both groups (P value > 0.05).

This was similar to what was concluded in Mehdorn et al. (2022)[5] study that none of various risk factors (Sex, BMI, alcohol abuse, and smoking) were found to be associated with POPF after splenectomy.

In 2001, one of the considered independent risk factors that were analyzed by Park et al.[49] was the existence of previous comorbidities in patients.

In our study, no statistically significant difference was detected regarding to diabetes mellitus & arterial hypertension in both groups (P value > 0.05). this was also corresponding to what was proved in Mehdorn et al. (2022)5 study.

Age, blood transfusion, thoraco-abdominal approach, operating time, and pneumonia have all been reported as risk factors for mortality following nontraumatic splenectomies.[51] In a study published in 2014, Gianchandani Moorjani et al.52 discovered that the ASA score, age, leukocytosis, blood transfusion, pleural effusion, and chest infection were all significant risks for death.

This contrasted with what was proved in this current study in which a statistically significance didn't be detected regarding to ASA status of patients in both groups (P value > 0.05). in this study, the most common ASA physical status in both POPF/BL & non-POPF/BL groups was ASA 2 representing 49.5% & 49.7% respectively, while the least common ASA status in both groups was ASA 4 in only 3.3% & 2.1% of patients respectively.

Also, this corresponds to what was mentioned in

Mehdorn et al. (2022)[5] study in which no statistically significant difference was detected regarding the ASA status of patients in both groups (P value = 0.188). Also, in Mehdorn et al. (2022)5 study, the most common ASA physical status in POPF/BL & non-POPF/BL groups was ASA 3 (44.4%) & ASA 2 (23.2%) of patients respectively.

Secondary splenectomy has been found to be an independent risk factor for biochemical leak (BL) post splenectomy. As a result, POPF and BL are important post-splenectomy sequelae to be aware of, particularly in situations of secondary splenectomy.[5]

pancreatic injury may also increase in patients with lymphoma and hilar lymphadenopathy when the dissection plan is unclear as well as in patients who have bleeding during surgery due to hilar lesions, leading to hemostatic actions, which may injure the pancreatic tail.[49]

In this current study, in the POPF/BL group, the most common primary indication for open splenectomy was splenic abscess (13.1%), while the commonest secondary indication was post traumatic splenic injury (31.3%). in the non-POPF/BL group, the post traumatic splenic injury was also the commonest secondary indication (38.8%) while the most common primary indications were the primary splenic mass & Immune thrombocytopenic purpura (ITP) (9.8% & 9.5% respectively). Also, Interestingly, POPF/BL was noted significantly more often after gastrectomies and colectomies due to malignancy (14.4% vs 2% with P value = 0.011 and 13.6% vs 2.6% with P value = 0.013, respectively).

ITP was discovered to be the most frequent primary indication for open splenectomy in both the POPF/BL and non-POPF/BL groups in the study by Mehdorn et al. (2022)[5] (13.9% and 29.9%, respectively). Although other gastrointestinal neoplasms other than esophageal & colorectal were the commonest secondary indication in the non-POPF/BL group (10.9%), cancer esophagus was the most common secondary indication in the POPF/BL group (11.1%). Additionally, it was noted that POPF/BL was substantially more frequent after esophagectomy and colectomy procedures (11.1% vs 2.8%, P value = 0.042 and 8.3% vs 1.4%, P value = 0.042 respectively).

In this current study, statistically significant differences were found in indications in benign indications such as splenic abscess & splenic rupture and malignant indications e.g., gastric carcinoma & left colon carcinoma (P value < 0.05).

This is consistent with the finding reported in the Casaccia et al. (2006)[53] study that the only preoperative clinical criterion identified as a predictor of postoperative complications was malignant tumors. Given that they are frequently caused by inflammatory and malignant peri splenitis, even diaphragm lesions with a 0%–14% rate was affected by malignancies.

As the pancreatic tail is close to the spleen anatomically, there is a risk of pancreatic injury during intraoperative spleen mobilization, particularly in those with a challenging situation, such as history of previous abdominal operations with adhesions, pancreatitis, or colitis.[5]

In this study, it was found that 22.9% & 12.9% patients in the POPF/BL & non-POPF/BL groups respectively had history of previous abdominal surgical interventions, but without any statistically significant differences. This is similar to what was proved in Mehdorn et al. (2022)[5] study in which previous abdominal surgery were recorded in 11.1% & 17.1% of the POPF/BL & non-POPF/BL groups respectively without statistical significance also.

partial splenectomy with some splenic tissue retention whenever possible, especially in children post splenic trauma, has increased due to the increased awareness of potential long-term side effects and the increasing evidence of the failure of prophylactic measures. Children have a higher proportion of splenic capsular tissue to splenic pulp tissue, making splenic salvage procedures more achievable. They involve segmental vascular ligation, partial splenectomy, splenorrhaphy, and repair of the splenic capsule. Partial splenectomy could be performed with deep lacerations to the splenic hilum but should only be done when there are no other serious injuries because it is a difficult & time-consuming procedure.[3]

In this current study, full splenectomy was done in 100% of patients of the POPF/BL group, while in the non-POPF/BL group, only 8.3% patients underwent partial splenectomies.

Use of energy-based devices was recognized as an independent risk factor in multivariate analysis when it was evaluated along with BL (Reflecting the prior POPF definition from the 2005 ISGP statement). The use of energy-based devices and postoperative complications, however, were found to be significant in an unadjusted univariate analysis when only focusing on clinically relevant POPF of grade B & C, whereas only the operative time was detected to be significant in a multivariate analysis and therefore recognized as an independent risk factor for POPF.[5]

Additionally, the length of surgery was regarded as one of the independent risk factors augmenting the likelihood of complications after splenectomy in the study by Park et al. (2001).[49]

This doesn't correspond to what was found in this current study as no statistically significant difference was detected regarding the duration of surgery (P value = 0.087). While in the study of Mehdorn et al. (2022),[5] statistically significant differences in the univariate analysis (P value = 0.005) and the multivariate analysis (P value < 0.001) were discovered regarding the operative time that was significantly longer in patients who had a POPF/BL (273.3±160.8 min. vs 190.6±97.6 min. in the non-POPF group). This difference between this current study & Mehdorn et al. (2022)[5] study may be attributed to larger sample size of patients included in our study & the involvement of a less experienced surgical staff in our department for the purpose of improving learning curve of young surgeons according to policy of the ministry of health at Saudi Arabia.

Spleen weight is the most effective predictor of morbidity, as demonstrated by Boddy et al. (2006)54, who found that patients with a splenic weight more than 1 kg had a 14-fold increased risk of morbidity. Splenomegaly is a risk factor for complications after splenectomy. For every 100 gm beyond 1000 gm of splenic weight, the probability of morbidity raised by 0.1%, and the probabilities were five times higher for males than for females.[40]

This also doesn't match with what was found in our study in which no significant difference was found regarding splenic weight (P value = 0.42). But it was noted that Romano et al. (2011)40 study described risk factors and outcomes of patients who underwent either open splenectomy or laparoscopic splenectomy which can be considered the reason for this conflict in data results between our study & Romano et al. (2011)[40] study.

Additionally, the results of our study are consistent with a meta-analysis by McAneny et al. (1998)55, which demonstrated that spleen size was not a risk factor after adjusting for age and diagnosis using multivariate analysis.

The most frequent intraoperative complication is hemorrhage, with incidence rates from 1.9% to 20% with an average rate of 6.7% in various studies. Additionally, it is the most frequent justification for a "second look" surgery in the immediate postoperative time.[40]

This corresponds to what was detected in our study in which intraoperative bleeding was the most frequent intraoperative complication that occurred in 92 patients (18.6% of intraoperative complications) of which 39 patients developed POPF. A statistically significant difference was detected regarding the intraoperative complications (P value < 0.05).

This doesn't match with Mehdorn et al. (2022)5 study in which Intraoperative complications did not proved to be of statistical significance (P value = 1).

The ISGPF definition and grading of POPF were validated in a number of studies. In 2007, it was used by Pratt et al.[56] in a study that involved 176 consecutive patients. They discovered that all clinical outcomes were similar between patients without fistula and who developed grade A fistulas (BL); also, expenditures, lengths of hospital stay and ICU stays, and resource usage all increased progressively in patients with grade A to grade C POPFs.

In the current study, both univariate & multivariant analysis confirmed a statistically significant difference regarding the hospital stay that was longer in the POPF/BL group (P value < 0.05). While in Mehdorn et al. (2022)[5] study, although the mean length of hospital stay was longer for POPF/BL patients (34.3 days vs 25.5 days for non-POPF/BL), this did not reach statistical significance.

In this current study, There were only 24 (11.2%) patients that were discharged from the hospital with a drain and all of them were of the POPF/BL group with a statistically significant difference was identified (P value < 0.05). In Mehdorn et al. (2022)[5] study, nearly a third (27.8%) of POPF/ BL patients were discharged with a drain and statistical significance was also found (P value < 0.001). This smaller percentage in our study than in Mehdorn et al. (2022)[5] study could be explained by our hospital policy that was preventing discharge of patient with a drain. The patients who were discharged with a drain refused to stay more time at the hospital & signed discharge against medical advice consent (DAMA). This also could explain the longer hospital stay in the POPF/BL group patients.

Potential post-splenectomy complications could result from the procedure itself or from the asplenic condition's consequences. Post-surgical early complications can be categorized into 2 types: minor and major according to modified Clavien–Dindo classification. Minor complications (Clavien-Dindo grades I and II) that require medications or lead to a longer hospital stay involve fever, wound pain, pain radiating to the left shoulder from pneumoperitoneum, pleural effusion, and atelectasis that regresses after respiratory physiotherapy, bronchopneumonia (BPN), portal or splenic vein thrombosis (PSVT) as well as surgical site infection managed by only antibiotics, isolated hyperamylasemia, minor pancreatitis, and mild hematoma that spontaneously reabsorbed. Whereas quite rare major complications (Clavien–Dindo grade III and IV) that require more invasive management involve larger hematomas, subphrenic abscess, wound infection, pleural & peritoneal effusion that require drainage, gastroparesis, ileus, postoperative pancreatic fistula, injury to abdominal organ (Gastric 1%, colonic, diaphragmatic 0%-14%), hemorrhage and PSVT complicated by intestinal infarction.[40]

In the current study, 484 (28.9%) patients of the 1672 patients developed various post splenectomy complications other than POPF. The most common Clavien–Dindo classification grade was grade I that involved 49.2% patients with post splenectomy complications. While the least common grade was grade IVb that included only 4 patients (0.8%) that were admitted to ICU with multiorgan failure & recovered. The most common post splenectomy complication was thrombocytosis and leukocytosis that occurred in 28.3% of patients who developed post operative complications. While the least common complication was Overwhelming postoperative infection (OPSI) +/- disseminated intravascular coagulation (DIC) that occurred in only 2 (0.4%) patients.

In a study done by Wysocki et al. (2018),[57] it was noted that there were 23 cases (4.91%) of major complications (III–V classes according to Clavien-Dindo classifications) with postoperative bleeding in 6 (1.28%) cases & subphrenic abscess 6 (1.28%) patients requiring re-operations being the most common complications. Only 2 patient (0.42%) died; the 1st one was due to Pulmonary embolism, while the 2nd one was due to massive intraoperative blood loss with reoperation for recurrent hemorrhage. While there were 16 patients (3.42%) of minor complications (I–II classes according to Clavien-Dindo classifications) in which Fever of unknown origin was the most common that occurred in 7 (1.50%) patients.

In 2005, the International Study Group of Pancreatic Fistula [ISGPF] published an article where they confirmed that the practical application of a suggested classification of POPF would prove its clinical significance and provide reliable comparison across various surgical approaches worldwide. Actually, eleven years after the classification was first published, the ISGPS has reevaluated its impact and can confirm that its primary goals have been achieved. POPF has a standardized definition in clinical terminology. The concept was strengthened by the large number of citations of the original 2005 ISGPF paper that reached 1707 times and the nearly universal approval of this definition and classification of POPF. The rationale for the 2017 modification was the same need for clarity and simplicity as the original 2005 ISGPF classification. From a clinical, economical, and academic perspective, many research studies have validated the classification system developed by the ISGPF and have proved its effectiveness and acceptance.[9]

In this current study, it was found that biochemical leak (BL) or formerly grade A POPF was the most common grade including 7.4% of all included patients in this study with only increased amylase level in the drain > 3 times upper limit normal serum value & stopped spontaneously within 3 weeks with conservative management with/without the aid of octreotide administration. Grade B POPF involved 4.1% patients who all developed persistent peripancreatic drainage > 3 weeks with clinically relevant change in management of POPF. Grade C POPF included 22 (1.3%) patients with only 2 patients died post re-laparotomy due to severe sepsis.

In Mehdorn et al. (2022)[5] study, 14.6% of patients who were enrolled in their research had POPF or BL. The clinical outcomes of the 36 POPF/BL patients were analyzed, and it was discovered that the 25 BL patients had conservative management without requiring any further intervention, and 4 POPF patients were classified as grade B POPF for having prolonged (>21 days) drainage but did not require any additional intervention. Also, 3 patients were categorized as grade B POPF as they needed more invasive procedures, such as coiling a splenic artery aneurysm, placing a drain under CT guidance, and inserting a pancreatic stent endoscopically in one patient. Grade C POPF was assigned to 4 patients because they required relaparotomies for intraabdominal access (n=3) or hemorrhage (n=1), all of those required surgical replacement of a drain. In their study, no mortality among patients who acquired POPF/BL was noted.

BL & POPF were found significantly to be less frequently after primary splenectomies than after secondary splenectomies. Moreover, BL was found in most patients and could frequently be managed with conservative treatment without causing further morbidity. Although post-secondary splenectomy pancreatic fistula is limited (2.5%), it may be a related complication that the surgeon should take care about.[13]

In this current study, univariate & multivariate analysis confirmed that indication for splenectomy (primary vs secondary) was an independent risk factor for the development of POPF/BL after splenectomy. BL occurred in 4.6% post-primary splenectomies and 9.5% of post-secondary splenectomies, and POPF of grade B was noted in 3.7% of post-primary splenectomies and 4.3% of post-secondary splenectomies patients, while POPF of grade C occurred in 0.85% of post-primary splenectomies and 1.7% of post-secondary splenectomies patients.

This is similar to what was mentioned in Mehdorn et al. (2022)[5] study in which BL occurred in 5.5% of post-primary splenectomies and 19.0% of post-secondary splenectomies patients, and POPF of grade B was noted in 1.8% of post-primary splenectomies and 4.7% of post-secondary splenectomies patients, while POPF of grade C occurred in 0.6% of post-primary splenectomies and 3.6% of post-secondary splenectomies patients. Also, it was proved that indication for splenectomy could be considered as an independent risk factor for the development of

POPF/BL after splenectomy.

Conclusions

Splenectomies are frequently thought of being learning surgeries. following splenectomy, biochemical leak (BL) & POPF are related complications that are observed considerably more frequently following secondary splenectomies. The analysis presented here serves as a further reminder to the surgical society that such surgeries carry a high risk of POPF development and that skilled (Pancreatic) surgeons should be available, particularly in cases of challenging situations.

The 2016 modified definition & classification of the International Study Group (ISGPS) for postoperative pancreatic fistula is a straightforward, helpful criteria for categorizing POPF that continues to be the fundamental step in creating strategies for avoiding and managing POPF. the ability for proper evaluation of the effectiveness of different surgical techniques and mitigation plans as well as reviewing surgical performance has been achieved by the application of ISGPF classifications. So, It is acceptable that patients with a certain risk who are indicated for a primary splenectomy, or an anticipated secondary splenectomy need to be referred to centers with experience in pancreatic surgery as well as splenectomy to prevent inability to manage cases with challenging postoperative course due to POPF.

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