Splenectomy for benign and malignant hematologic pathology: Modern morbidity, mortality, and long-term outcomes

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Abstract

Background: The role of splenectomy to diagnose and treat hematologic disease continues to evolve. In this single-center retrospective review, we describe modern morbidity, mortality, and long-term outcomes associated with splenectomy for benign and malignant hematologic disorders.

Methods: We analyzed all nontrauma splenectomies performed for benign or malignant hematologic disorders from January 2009 to September 2018. Variables collected included demographics, preexisting comorbidities, laboratory results, intra- and postoperative features, and long-term follow-up. Outcomes of interest included postoperative complications, 30-day mortality, and overall mortality.

Results: We identified 161 patients who underwent splenectomy for hematologic disorders. Median age was 54 years (range 19–94), and 83 (52%) were female. Splenectomy was performed for 95 (59%) patients with benign hematologic disorders and for 66 (41%) with malignant conditions. Most splenectomies were laparoscopic (76%), followed by laparoscopic hand assisted (11%), open (8%), and laparoscopic converted to open (6%). Median follow-up was 761 days (interquartile range: 179–2025 days). Major complications occurred in 21 (13%) patients. Three (2%) patients died within 30 days; 16 (9%) died more than 30 days after operation, none from surgical complications, with median time to death of 438 days (interquartile range: 231–1497 days). Among malignant cases, only preoperative thrombocytopenia predicted death (odds ratio = 5.8, 95% confidence interval = 1.1–31.8, P = .04). For benign cases, increasing age was associated with inferior survival (odds ratio = 2.3, 95% confidence interval = 1.0–5.1, P = .05).

Conclusion: Splenectomy remains an important diagnostic and therapeutic option for patients with benign and malignant hematologic disorders and can be performed with a low complication rate. Despite considerable burden of comorbid disease in these patients, early postoperative mortality was uncommon.

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| Demographic variables                  | All cases | Benign (n = 95) | Malignant (n = 66) | P value |
|----------------------------------------|-----------|----------------|-------------------|---------|
| Demographic variables                  |           |                |                   |         |
| Male sex (%)                           | 78 (48)   | 35 (37)        | 43 (64)           | < .0001 |
| Age, median (range), y                 | 54 (19-94)| 45 (19-94)     | 62 (21-83)        | < .0001 |
| Race, no. (%)                          |           |                |                   |         |
| White                                  | 99 (61)   | 51 (54)        | 48 (73)           | .01     |
| Hispanic                               | 28 (17)   | 23 (24)        | 5 (8)             |         |
| Asian                                  | 18 (11)   | 8 (8)          | 10 (15)           |         |
| Other                                  | 11 (7)    | 8 (8)          | 3 (5)             |         |
| Black                                  | 3 (2)     | 3 (3)          | 0 (0)             |         |
| Native Hawaiian                        | 1 (1)     | 1 (1)          | 0 (0)             |         |
| American Indian                        | 1 (1)     | 1 (1)          | 0 (0)             |         |
| Benign, no. (%)                        | 95 (59)   |                |                   |         |
| Autoimmune hemolytic anemia           | 19 (12)   | 1 (1)          | 1 (1)             |         |
| Beta thalassemia                       | 1 (1)     | 2 (2)          | 1 (1)             |         |
| Evans syndrome                         | 4 (2)     | 1 (1)          | 1 (1)             |         |
| Heeditary spherocytosis                | 10 (6)    | 1 (1)          | 1 (1)             |         |
| Idiopathic thrombocytopenic purpura    | 60 (37)   | 1 (1)          | 1 (1)             |         |
| Thrombotic thrombocytopenic purpura    |           |                |                   |         |
| Comorbidities, no. (%)                 |           |                |                   |         |
| Hypertension                           | 62 (39)   | 35 (37)        | 27 (41)           | .6      |
| Hyperlipidemia                         | 41 (25)   | 19 (20)        | 22 (33)           | .07     |
| Diabetes                               | 26 (16)   | 15 (16)        | 11 (16)           | 1.0     |
| Chronic obstructive pulmonary disease  | 6 (4)     | 5 (5)          | 1 (1)             | .4      |
| Asthma                                 | 8 (5)     | 5 (5)          | 3 (4)             | 1.0     |
| Renal disease                          | 12 (7)    | 8 (8)          | 4 (6)             | .8      |
| Cardiac disease                        | 22 (14)   | 10 (11)        | 12 (18)           | .2      |
| Chronic steroid use                    | 61 (38)   | 55 (58)        | 6 (9)             | < .0001 |
| Current or former smoker               | 56 (35)   | 28 (29)        | 28 (42)           | .1      |
| Partially or completely dependent      | 5 (3)     | 0 (0)          | 5 (7)             | .01     |
| Leukopenia                             | 29 (19)   | 8 (9)          | 21 (32)           | .001    |
| Anemia                                 | 93 (61)   | 50 (56)        | 43 (67)           | .2      |
| Thrombocytopenia                       | 46 (30)   | 31 (35)        | 15 (23)           | .1      |
| Hypoalbuminemia                        | 55 (49)   | 30 (30)        | 25 (48)           | .9      |
| Coagulopathy                           | 22 (24)   | 9 (18)         | 13 (22)           | .1      |
| Hyperbilirubinemia                     | 29 (26)   | 17 (29)        | 12 (23)           | .5      |
| Treatment and outcome variables        |           |                |                   |         |
| Splenectomy approach, no. (%)          |           |                |                   | < .0001 |
| Open                                   | 12 (8)    | 5 (5)          | 7 (11)            |         |
| Laparoscopic                           | 122 (76)  | 83 (88)        | 39 (59)           |         |
| Laparoscopic hand assisted             | 18 (11)   | 5 (5)          | 13 (20)           |         |
| Laparoscopic converted to open         | 9 (6)     | 2 (2)          | 7 (11)            |         |
| Intraoperative transfusion required, no. (%) | 33 (20)   | 17 (18)        | 16 (24)           | .3      |
| Weight of spleen, median (range), g    | 306.5 (49–5650) | 182.5 (49–1900) | 742 (82–5650) | < .0001 |
| Accessory spleen present, no. (%)      | 13 (8)    | 9 (9)          | 4 (6)             | 1.0     |
| Hospital length of stay, median (range), d | 2 (1–41) | 2 (1–27)       | 3 (1–41)          | .01     |
| Required intensive care unit admission, no. (%) | 9 (6)     | 5 (5)          | 4 (6)             | 1.0     |
| Patients with complications, no. (%)   | 21 (13)   | 14 (15)        | 7 (11)            | .5      |
| Portal, mesenteric, or splenic vein thrombosis | 9 (6)       | 7 (7)            | 2 (3)            | .3      |
| Postoperative bleeding related transfusion | 5 (3)      | 2 (2)          | 3 (4)             | .4      |
| DVT or pulmonary embolism             | 5 (3)     | 4 (4)          | 1 (2)             | .8      |
| Surgical site infection                | 5 (3)     | 3 (3)          | 2 (3)             | 1.0     |
| Sepsis                                 | 4 (2)     | 3 (3)          | 1 (1)             | .6      |
| Pneumonia                              | 3 (2)     | 2 (2)          | 1 (1)             | 1.0     |
| Pancreatic leak                        | 2 (1)     | 1 (1)          | 1 (1)             | 1.0     |
| Renal failure                          | 1 (1)     | 1 (1)          | 0 (0)             | 1.0     |
| Overwhelming postsplenectomy sepsis    | 1 (1)     | 1 (1)          | 0 (0)             | 1.0     |
| Reparation required                    | 1 (1)     | 1 (1)          | 0 (0)             | 1.0     |
| Postoperative DVT chemoprophylaxis used | 81 (50)   | 41 (43)        | 40 (61)           | .04     |
hematologic pathology were included. Splenectomies performed for trauma or for other nonhematologic malignancies and splenectomies performed on persons <18 years of age were excluded. Variables assessed included demographics, preexisting comorbidities and laboratory results, intra- and postoperative features, and long-term follow-up variables.

Leukopenia was defined as a white blood cell count <4.0 x 10^9/L. Anemia was defined as a hemoglobin <12 g/dL for females and <13 g/dL for males. Thrombocytopenia was defined as <50,000 platelets/μL. Hypoalbuminemia was defined as <3.5 g/dL. An elevated total bilirubin was defined as >1.2 mg/dL. Coagulopathy was defined as an international normalized ratio >1.3. Patient records were evaluated until death or last documented follow-up within our health care system. Outcomes of interest included postoperative complications, 30-day mortality, and overall mortality. Complications were evaluated as end points independent of death.

Fisher exact and Mann-Whitney U tests were used for univariate analysis where appropriate. An a priori P value considered significant on univariate analysis for inclusion into multivariate models was P < .05. A P < .05 was considered significant on multivariate analysis. Multivariate logistic regression was used to assess predictors of postoperative complication and mortality. Stata 12.0 (StataCorp, College Station, TX) was used for statistical analyses. This study received institutional review board approval.

RESULTS

There were 161 patients who had a splenectomy over the 10-year time period (Table I). Ninety-five (59%) patients had a splenectomy performed for benign conditions, with immune thrombocytopenia being the most common indication (n = 60, 63% of benign indications). Sixty-six (41%) patients had a splenectomy performed for malignant conditions; the most frequent diagnosis was marginal zone lymphoma (n = 60, 63% of benign indications). Median patient age was 54 years (range: 19–94), and 83 (52%) were female. Patients diagnosed with malignant disease were significantly older (62 vs 45 years, P < .0001). Common comorbidities among patients included anemia (n = 93/152, 61%), hypoalbuminemia (n = 55/112, 49%), hypertension (n = 62/159, 39%), chronic steroid use (n = 61/161, 38%), and a history of smoking (n = 66/161, 41%). Chronic steroid use was more common among patients with benign pathology (58% vs 9%, P < .0001). The only patients who were partially or completely dependent on others with respect to activities of daily living were patients with hematologic malignancies (n = 5, 7%). Leukopenia was more common among patients with hematologic malignancies compared to benign pathology (32% vs 9%, P = .001).

There were 122 (76%) laparoscopic splenectomies, 18 (11%) laparoscopic hand-assisted splenectomies, 12 (8%) open splenectomies, and 9 (6%) laparoscopic converted to open splenectomies. Average spleen weight in our cohort was 306.5 g (range: 49.0–5650.0 g), and spleen weight was significantly higher in the malignant group (742.0 vs 182.5 g, P < .0001). Open, laparoscopic hand-assisted, and laparoscopic cases converted to open were more common among patients with hematologic malignancies when compared to benign pathology (11% vs 5%, 20% vs 5%, and 11% vs 2%, respectively; P < .0001). Thirty-three (20%) splenectomies required intraoperative transfusion with packed red blood cells, fresh-frozen plasma, or platelets because of preoperative anemia or thrombocytopenia and intraoperative blood loss. Median hospital length of stay was 2 (range: 1–41) days, and 9 (6%) patients required intensive care unit admission postoperatively. The median hospital length of stay was longer for patients with hematologic malignancies versus those with benign disorders (2 vs 3 days, P = .01). The most common complication after surgery was portal, mesenteric, or splenic vein thrombosis (n = 9, 6%). Other postoperative complications included postoperative bleeding requiring transfusion (n = 5, 3%), peripheral deep vein thrombosis or pulmonary embolism (n = 5, 3%), surgical site infection (n = 5, 3%), sepsis (n = 4, 2%), pneumonia (n = 3, 2%), pancreatic leak (n = 2, 1%), renal failure (n = 1, 1%), and overwhelming postsplenectomy sepsis (n = 1, 1%). Complication rates were not significantly different between patients with benign and malignant pathology. Reoperation for bleeding was required for 1 (1%) patient.

Nineteen (12%) patients died during follow-up. 3 (2%) of whom died within 30 days. Of the 3 patients who died within 30 days of surgery, 1 was a patient with T-cell lymphoma who died after suffering a cerebrovascular accident and decompensated heart failure on postoperative day (POD)6. The second patient with a diagnosis of immune thrombocytopenic purpura (ITP) died after developing diffuse alveolar hemorrhage and respiratory failure on POD13. The third patient with a diagnosis of Evans syndrome died on POD15 after developing a pulmonary embolus and cardiac arrest. Among the 16 (9%) of patients who died after 30 days, median time to death was 438 (interquartile range [IQR]: 231–1497) days. Death after 30 days was more common among patients with hematologic malignancy (n = 13, 19%) compared to patients with benign pathology (n = 3, 3%, P = .001) (Fig.). Median follow-up among all patients, both those who survived and those who died, was 761 (IQR: 179–2025) days.

Eighty-one (50%) patients were started postoperatively on venous thromboembolic (VTE) chemoprophylaxis, more commonly among patients with malignant than benign disorders (61% vs 43%, P = .04). Receipt of VTE prophylaxis was not associated with a reduction in VTE incidence or an increase in bleeding rates compared to patients who did not receive VTE prophylaxis, although event rates were low.

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**Table I (continued)**

| Event | All cases | Benign (n = 95) | Malignant (n = 66) | P value |
|---|---|---|---|---|
| Postdischarge DVT chemoprophylaxis prescribed | 20 (12) | 18 (19) | 2 (3) | P = .003 |
| Total deaths, no. (%) | 19 (12) | 5 (5) | 14 (21) | P = .005 |
| Death within 30 d, no. (%) | 3 (2) | 2 (2) | 1 (1) | P = .1 |
| Death after 30 d, no. (%) | 16 (9) | 3 (3) | 13 (19) | P = .001 |
| Time to death if more than 30 d after surgery, median (range), d | 447 (44–2477) | 378 (250–2477) | 447 (44–2052) | P = .6 |
| Follow-up, median (range), d | 761 (2–3580) | 643 (2–3323) | 917 (6–3560) | P = .1 |

DVT, deep vein thrombosis.
In univariate analysis of patients with benign hematologic disorders, demographic variables associated with complications included male sex (n = 2/13, 15%, P = .1), anemia (n = 10/13, 77%, P = .1), coagulopathy (n = 3/7, 43%, P = .06), and hyperbilirubinemia (5/6, 83%, P = .006) (Table II). Variables associated with mortality on univariate analysis among the same benign hematologic pathology subgroup included increased age (P = .006), hypertension (n = 4/5, 80%, P = .06), anemia (n = 5/5, 100%, P = .07), and hyperalbuminemia (n = 4/4, 100%, P = .05). On multivariate analysis, no patient demographic factors were associated with development of complications. Even after excluding patients with ITP, no demographic variable was associated with development of complications. Only increased age was associated with death after splenectomy for benign hematologic conditions (odds ratio [OR] = 2.26, 95% confidence interval [CI] 1.00–5.11) on multivariate analysis.

Among patients who underwent splenectomy for malignant hematologic indications, chronic steroid use (n = 2/7, 29%, P = .1), thrombocytopenia (n = 5/8, 63%, P = .006), hyperalbuminemia (n = 6/7, 86%, P = .04), and coagulopathy (n = 4/6, 67%, P = .03) were associated with complications on univariate analysis (Table III). Hypertension (n = 3/14, 21%, P = .1), thrombocytopenia (n = 7/14, 50%, P = .01), hyperalbuminemia (n = 9/12, 75%, P = .05), and hyperbilirubinemia (n = 5/12, 42%, P = .1) were associated with death on univariate analysis. Similar to patients with benign disorders, on multivariate analysis, there were no demographic variables that remained associated with the composite complication variable among patients with malignant conditions; only thrombocytopenia was associated with death (OR = 5.76, 95% CI 1.05–31.77, P = .04).

**DISCUSSION**

New treatment options have emerged for the management of benign and malignant hematologic disorders including the use of monoclonal antibodies, immune-modulating therapies, and synthetic thrombopoietin receptor agonists [8,9]. As a result, indications for splenectomy in the management of these diseases have undergone considerable evolution over the last decade [10,11]. Despite these new treatment options, surgical intervention with splenectomy has remained an important diagnostic and therapeutic option for patients with recalcitrant disease and complications from splenomegaly.

In this single-center retrospective analysis, we describe 161 patients who underwent splenectomy for a variety of benign and malignant hematologic disorders. We demonstrate that the majority of patients in this cohort underwent successful splenectomy with a relatively low rate of postoperative complications. Both short- and long-term postoperative mortality rates were low in our cohort. Most (76%) patients are able to undergo laparoscopic surgery, irrespective of spleen size. This is consistent with recent findings that laparoscopic splenectomy has replaced open splenectomy as the criterion standard surgical intervention even in patients with massive splenomegaly [12].

Both laparoscopic splenectomy and open splenectomy were performed with very low rates of complications. The most common
complication was portal, mesenteric, and splenic vein thrombosis (cumulative 6%). After identification of thrombosis, these patients were treated successfully with systemic anticoagulation and did not require further operative intervention. This is consistent with practice recommendations from a meta-analysis which showed 67% complete resolution of symptomatic splenic vein thrombosis after splenectomy with therapeutic anticoagulation [13]. The increased risk of portal vein thrombosis in patients undergoing splenectomy is thought to be secondary to the acute increase in platelet count and reduction in portal blood flow after removal of the spleen [14]. Interestingly, the use of postoperative VTE chemoprophylaxis was associated with neither VTE incidence nor bleeding rate. It is important to note that our study was retrospective and not adequately powered to evaluate or quantify the impact of VTE prophylaxis on thrombosis or bleeding risk. 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Thrombocytopenia is commonly observed among patients with hematologic malignancy and can be seen in 5%–30% of patients depending on the underlying pathology. In our cohort, thrombocytopenia was an independent predictor of mortality among patients with malignant hematologic disorders. Recent data among critically ill patients with hematologic malignancy indicate inferior outcomes among patients with thrombocytopenia and organ failure compared to those without [19]. It is possible that preexisting thrombocytopenia is reflective of more advanced disease preoperatively, resulting from chemotherapy, disseminated intravascular coagulation, bone marrow failure, or a combination thereof [19].

At our institution, patients undergoing elective splenectomy for benign/malignant diseases typically receive vaccination against encapsulated organisms (Streptococcus pneumoniae, Haemophilus influenzae type B, Neisseria meningitidis) 2 weeks or more prior to their operation. In cases where an emergent operation is performed, the prophylactic vaccines are administered in the postoperative period prior to discharge. All patients are educated regarding the risks of asplenia, immunosuppression, and overwhelming postsplenectomy sepsis. Barriers any postoperative complications, patients are seen in scheduled follow-up 2 weeks postdischarge.

There are several limitations to this study. Firstly, this was a retrospective, single-institution study, and as such, our results may not be generalizable to other patient populations or institutions. Secondly, because we did not do a subgroup analysis of the various benign and malignant hematologic conditions, it is possible that important predictors of both morbidity and mortality in these patients could be obscured or missed for specific disease entities. Given the low group numbers of some of the conditions, we elected to not do specific subgroup analyses beyond malignant or benign categories. Finally, our study only included patients with hematologic diseases who underwent splenectomy. We did not include patients who were never referred to a surgeon or who were not taken for splenectomy after evaluation by a surgeon. We are unable to compare survival rates after surgery to a control group of patients with hematologic disorders not undergoing splenectomy. Selection bias may be present among patients undergoing surgery, as patients too frail to undergo surgery were selected out.

In conclusion, splenectomy remains an important adjunct for the management of patients with both benign and malignant hematologic disorders and can be performed with a low rate of complications using minimally invasive strategies. Despite a considerable burden of comorbid disease in this patient population, early postoperative mortality is uncommon, and the overall long-term survival after splenectomy is measured in years. Surgical intervention should be considered a tool that can be used selectively to improve outcomes in patients with hematologic disorders.

Conflict of Interest
The authors have no conflicts of interest to report.

Funding Sources
No funding was used to produce this manuscript.

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