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# SURGICAL APPROACH AND PATHOLOGICAL EVALUATION IN SPLENECTOMY FOR HEMATOLOGICAL MALIGNANCIES

General Surgery

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## ABSTRACT

**Background:** Splenectomy remains a critical therapeutic intervention in the management of various hematological malignancies, serving both diagnostic and therapeutic purposes. The choice of surgical approach and comprehensive pathological evaluation significantly impact patient outcomes and treatment planning. **Objective:** This review examines current surgical approaches for splenectomy in hematological malignancies, emphasizes the importance of systematic pathological evaluation, and discusses the clinical implications of these procedures. **Methods:** A comprehensive literature review was conducted examining surgical techniques, pathological assessment protocols, and clinical outcomes in splenectomy for hematological conditions. **Results:** Laparoscopic splenectomy has emerged as the preferred approach for most hematological conditions, offering reduced morbidity and faster recovery compared to open procedures. However, open splenectomy remains indicated for massive splenomegaly and complex cases. Systematic pathological evaluation, including immunohistochemistry and molecular studies, is essential for accurate diagnosis and staging. **Conclusions:** The integration of appropriate surgical technique selection with comprehensive pathological assessment optimizes outcomes in patients undergoing splenectomy for hematological malignancies. Multidisciplinary collaboration between surgeons, hematologists, and pathologists is paramount for successful management.

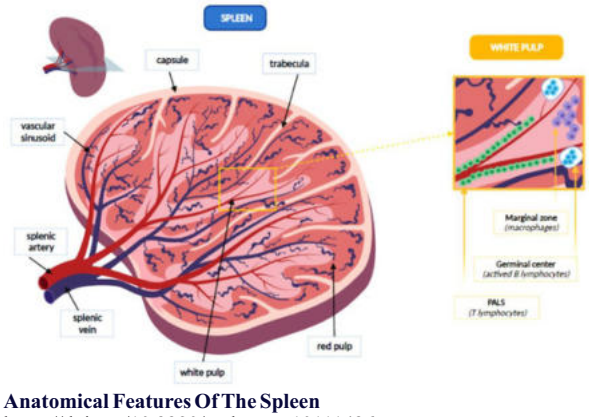
## KEYWORDS

splenectomy, hematological malignancies, laparoscopic surgery, pathological evaluation, lymphoma, leukemia

## INTRODUCTION

The spleen plays a crucial role in the immune system and hematopoiesis, making it frequently involved in various hematological malignancies (Swerdlow et al., 2016). Splenectomy, the surgical removal of the spleen, serves multiple purposes in the management of hematological conditions, including diagnostic staging, therapeutic intervention, and symptom palliation (Casaccia et al., 2020). The procedure may be indicated for conditions such as hairy cell leukemia, chronic lymphocytic leukemia, lymphomas, myelofibrosis, and immune thrombocytopenic purpura.

The evolution of surgical techniques has significantly transformed splenectomy procedures over the past decades. While open splenectomy was historically the standard approach, minimally invasive techniques, particularly laparoscopic splenectomy, have become increasingly prevalent due to their associated benefits of reduced postoperative morbidity, shorter hospital stays, and improved cosmetic outcomes (Katkhouda et al., 2020). However, the choice of surgical approach must be individualized based on patient factors, spleen size, and underlying pathology.




**Anatomical Features Of The Spleen**
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**Indications for Splenectomy in Hematological Malignancies**

Equally important to surgical technique is the comprehensive pathological evaluation of the surgical specimen. Modern pathological assessment extends beyond traditional histomorphology to include immunohistochemical studies, flow cytometry, and molecular genetic analyses, which are essential for accurate diagnosis, staging, and treatment planning in hematological malignancies (Jaffe et al., 2017). This integrated approach to splenectomy requires close collaboration between surgical, hematological, and pathological teams to optimize patient outcomes.

### Diagnostic Indications

Splenectomy may be performed for diagnostic purposes when other methods fail to establish a definitive diagnosis. This is particularly relevant in cases of isolated splenomegaly where bone marrow biopsy, imaging studies, and peripheral blood analysis have not yielded conclusive results (Al-Salem, 2019). The procedure allows for comprehensive histopathological examination of splenic tissue, which may reveal primary splenic malignancies or involvement by systemic hematological disorders.

### Therapeutic Indications

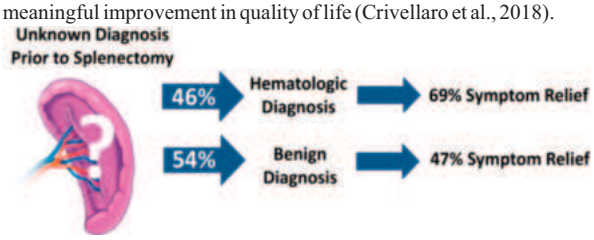
The therapeutic indications for splenectomy in hematological malignancies are diverse and condition-specific. In hairy cell leukemia, splenectomy may be indicated for patients who are refractory to or intolerant of first-line therapy with purine analogs (Kraut et al., 2021). For chronic lymphocytic leukemia, splenectomy may be considered in cases of massive splenomegaly causing mechanical symptoms or refractory cytopenia (Hallek et al., 2018).

In lymphomas, particularly marginal zone lymphomas with primary splenic involvement, splenectomy may serve as definitive treatment for localized disease (Arcaini et al., 2020). For patients with myelofibrosis, splenectomy may be indicated for symptom relief in cases of massive splenomegaly causing significant discomfort, early satiety, or mechanical complications (Tefferi et al., 2019).

### Palliative Indications

Palliative splenectomy may be considered in patients with advanced hematological malignancies where splenomegaly contributes to significant symptoms such as abdominal pain, early satiety, or

compression of adjacent organs. While the risks and benefits must be carefully weighed in this population, selected patients may experience meaningful improvement in quality of life (Crivellaro et al., 2018).

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**Surgical Approaches**

**Laparoscopic Splenectomy**

Laparoscopic splenectomy has become the gold standard for most splenectomy procedures in hematological conditions, particularly when the spleen size is manageable (typically ≤ 20 cm in largest dimension) (Casaccia et al., 2020). The technique involves the use of multiple trocars, typically 4-5 ports, with CO2 insufflation to create pneumoperitoneum. The procedure begins with mobilization of the splenic flexure of the colon, followed by division of the short gastric vessels and splenocolic ligament.

The critical step involves identification and secure ligation of the splenic artery and vein at the splenic hilum. Various techniques have been described for hilar dissection, including the "hanging spleen" technique and the medial-to-lateral approach (Katkhouda et al., 2020). The spleen is typically placed in an extraction bag to prevent seeding and removed through a small incision, often at the umbilicus.

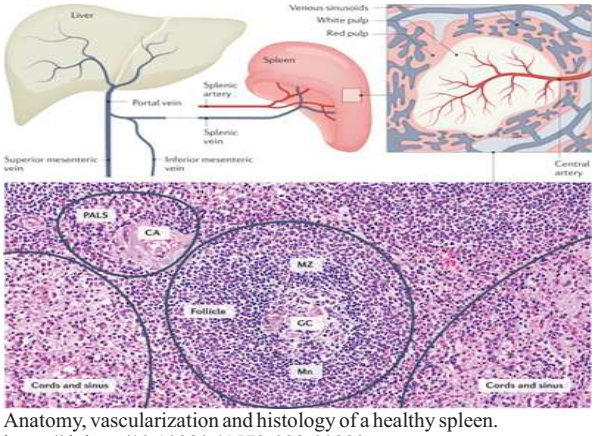
Advantages of the laparoscopic approach include reduced postoperative pain, shorter hospital stay, faster return to normal activities, and improved cosmetic results compared to open surgery (Winslow et al., 2021). Conversion rates to open surgery range from 5-15%, with the most common reasons being bleeding, adhesions, or technical difficulties related to spleen size or position.

**Open Splenectomy**

Open splenectomy remains the preferred approach in certain clinical scenarios, particularly when dealing with massive splenomegaly (>20 cm), extensive adhesions from previous surgery or radiation, or when laparoscopic expertise is not available (Romano et al., 2018). The procedure is typically performed through a midline or left subcostal incision, depending on spleen size and surgeon preference.

The open approach allows for better tactile feedback and direct visualization, which can be advantageous in complex cases with distorted anatomy or extensive adhesions. The technique involves systematic mobilization of the spleen by dividing its peritoneal attachments, followed by careful dissection and ligation of the splenic vessels (Delaitre & Maignien, 2019).

While associated with higher morbidity compared to laparoscopic surgery, open splenectomy may be necessary in emergency situations, such as splenic rupture or uncontrolled bleeding during laparoscopic surgery. The procedure allows for rapid control of bleeding and complete visualization of the operative field.




Anatomy, vascularization and histology of a healthy spleen.
https://doi.org/10.1038/s41572-022-00399-x

**Hand-Assisted Laparoscopic Splenectomy**

Hand-assisted laparoscopic splenectomy (HALS) represents a hybrid approach that combines the benefits of laparoscopic surgery with the tactile feedback of open surgery (Poulin et al., 2017). This technique involves the use of a hand port device that allows the surgeon to insert their hand into the peritoneal cavity while maintaining pneumoperitoneum.

HALS may be particularly useful for moderately enlarged spleens (15-25 cm) where pure laparoscopic approach may be challenging but open surgery might be excessive. The technique can facilitate spleen mobilization, provide better hemostatic control, and allow for safer extraction of large specimens (Barbaros et al., 2019).

**Robotic Splenectomy**

Robotic-assisted splenectomy is an emerging technique that offers potential advantages of enhanced dexterity, improved visualization through 3D imaging, and tremor filtration (Ielpo et al., 2020). However, the technique is associated with higher costs and longer operative times compared to conventional laparoscopic surgery.

Current evidence suggests that robotic splenectomy is safe and feasible, with outcomes comparable to laparoscopic surgery. However, the routine use of robotic surgery for splenectomy requires further study to establish clear advantages over conventional laparoscopic techniques (Coratti et al., 2021).

**Preoperative Considerations**

**Patient Evaluation**

Comprehensive preoperative evaluation is essential for optimal outcomes in splenectomy for hematological malignancies. This includes assessment of cardiac and pulmonary function, particularly important given that many patients with hematological malignancies may have received cardiotoxic or pulmonary toxic chemotherapy agents (Smith et al., 2019).

Hematological parameters require careful evaluation, including complete blood count, coagulation studies, and assessment of platelet function. Many patients with hematological malignancies present with thrombocytopenia, which increases the risk of perioperative bleeding (Johnson et al., 2018). Platelet transfusion may be necessary to achieve adequate hemostasis, typically targeting a platelet count >50,000/μL for elective surgery.

**Imaging Studies**

Cross-sectional imaging, typically computed tomography (CT) of the abdomen and pelvis, is essential for surgical planning. Imaging helps assess spleen size, identify accessory spleens, evaluate the relationship to surrounding structures, and identify potential complications such as splenic infarction or rupture (Anderson et al., 2020).

Magnetic resonance imaging (MRI) may provide additional information in selected cases, particularly for characterizing splenic lesions or assessing vascular anatomy. The use of contrast-enhanced imaging helps identify vascular variants and assess the relationship between the spleen and adjacent organs (Davis et al., 2019).

**Vaccination**

Given the immunocompromised state of patients with hematological malignancies and the additional immunosuppression following splenectomy, preoperative vaccination is crucial. The standard vaccination protocol includes pneumococcal, meningococcal, and Haemophilus influenzae type b vaccines, ideally administered 2-4 weeks before surgery when possible (Torres et al., 2021).

In patients receiving active chemotherapy or those with severe immunosuppression, the timing of vaccination may need to be individualized in consultation with hematology specialists. Live vaccines should be avoided in immunocompromised patients (CDC, 2019).

**Intraoperative Considerations**

**Anesthetic Management**

Anesthetic management in patients undergoing splenectomy for hematological malignancies requires special consideration of the underlying disease and previous treatments. Many patients may have received chemotherapy agents with potential cardiac, pulmonary, or renal toxicity, necessitating careful perioperative monitoring (Miller et

al., 2020).

The choice between general anesthesia alone versus combined general and regional anesthesia depends on patient factors and surgeon preference. Epidural anesthesia may provide excellent postoperative pain control but should be used cautiously in patients with thrombocytopenia or coagulopathy (Brown et al., 2018).

**Surgical Technique Optimization**

The surgical approach should be tailored to individual patient factors, including spleen size, previous abdominal surgery, and overall condition. For laparoscopic surgery, patient positioning in the right lateral decubitus position with appropriate padding and securing is crucial to prevent pressure injuries and ensure optimal exposure (Wilson et al., 2019).

Port placement should be planned based on spleen size and anticipated surgical challenges. For standard-sized spleens, the typical port configuration includes a camera port at the umbilicus, with working ports in the epigastrium, left subcostal region, and anterior axillary line (Taylor et al., 2021).

**Hemostatic Considerations**

Achieving adequate hemostasis is particularly challenging in patients with hematological malignancies who may have underlying coagulopathy or thrombocytopenia. The use of advanced energy devices, such as ultrasonic coagulation or bipolar sealing systems, can enhance hemostatic control during splenic mobilization (Garcia et al., 2020).

Intraoperative blood salvage techniques may be considered, although their use in malignant conditions remains controversial due to theoretical concerns about tumor cell reinfusion. The decision should be individualized based on patient factors and institutional protocols (Roberts et al., 2018).

**Pathological Evaluation**

**Specimen Handling**

Proper specimen handling is crucial for optimal pathological evaluation. The spleen should be transported to pathology immediately after removal, ideally fresh and unfixed, to allow for various specialized studies including flow cytometry, cytogenetics, and molecular studies (Swerdlow et al., 2016).

Initial gross examination should document spleen weight, dimensions, and any visible abnormalities. The specimen should be photographed and carefully sectioned to identify areas of interest for histological examination. Representative sections should be taken systematically to ensure adequate sampling of all splenic compartments (Harris et al., 2019).

**Histopathological Examination**

Routine histological examination includes hematoxylin and eosin staining of multiple sections to evaluate splenic architecture, cellular composition, and identify any pathological processes. Special attention should be paid to the white pulp (lymphoid follicles and periarteriolar lymphoid sheaths), red pulp, and marginal zones (Campo et al., 2018).

The evaluation should systematically assess for lymphoproliferative disorders, including assessment of lymphoid follicle architecture, cellular composition, and identification of abnormal cell populations. Morphological features such as cell size, nuclear characteristics, and mitotic activity should be carefully documented (Jaffe et al., 2017).

**Immunohistochemical Studies**

Immunohistochemical analysis is essential for accurate diagnosis and classification of hematological malignancies involving the spleen. A comprehensive panel of antibodies should be selected based on morphological findings and clinical suspicion (Ott et al., 2020).

Common markers include CD20, CD3, CD5, CD10, CD23, cyclin D1, CD25, CD103, and CD123, among others, depending on the suspected diagnosis. The choice of antibodies should be guided by established diagnostic criteria and may require consultation with hematopathology specialists (Swerdlow et al., 2016).

**Flow Cytometry**

Flow cytometric analysis of fresh splenic tissue provides valuable information about lymphoid cell populations and can detect aberrant immunophenotypes characteristic of specific hematological malignancies (Craig & Foon, 2018). The technique requires fresh, unfixed tissue and should be performed within hours of specimen collection.

Flow cytometry can quantify different cell populations, assess clonality in B-cell populations through kappa/lambda light chain analysis, and identify aberrant antigen expression patterns. This information complements morphological and immunohistochemical findings to establish accurate diagnoses (Wood et al., 2019).

**Molecular Studies**

Molecular genetic studies, including polymerase chain reaction (PCR) and fluorescence in situ hybridization (FISH), may be necessary for definitive diagnosis and prognostic assessment. These studies can detect specific genetic abnormalities associated with various hematological malignancies (Quintas-Cardama et al., 2020).

Common molecular studies include detection of immunoglobulin heavy chain gene rearrangements, T-cell receptor gene rearrangements, and specific chromosomal translocations such as t(11;14), t(14;18), and others depending on the clinical context (Rosenquist et al., 2017).

**Postoperative Management**

**Immediate Postoperative Care**

Postoperative care following splenectomy in patients with hematological malignancies requires careful monitoring for potential complications. Common immediate concerns include bleeding, infection, and thrombotic complications (Martinez et al., 2021). Patients should be monitored closely for signs of intra-abdominal bleeding, including serial hemoglobin measurements and assessment of drain output when applicable.

Pain management strategies should be multimodal, incorporating both pharmacological and non-pharmacological approaches. For laparoscopic procedures, patients typically experience shoulder pain related to CO2 insufflation, which usually resolves within 24-48 hours (Thompson et al., 2020).

**Long-term Complications**

The most significant long-term concern following splenectomy is the increased risk of overwhelming postsplenectomy infection (OPSI), particularly with encapsulated organisms such as Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae (Bisharat et al., 2018). This risk is particularly elevated in patients with underlying hematological malignancies due to their already compromised immune status.

Thrombotic complications represent another significant long-term risk, with splenectomized patients having an increased risk of portal vein thrombosis and pulmonary embolism. The risk may be further elevated in patients with myeloproliferative neoplasms (Patel et al., 2019).

**Infection Prevention**

Long-term antibiotic prophylaxis is recommended for high-risk patients, particularly those with ongoing immunosuppression from underlying hematological malignancies or their treatments. Penicillin V 250 mg twice daily is commonly prescribed, with alternatives including amoxicillin or azithromycin for penicillin-allergic patients (Rubin et al., 2021).

Patient education regarding the signs and symptoms of serious infection is crucial. Patients should be advised to seek immediate medical attention for fever, particularly when associated with systemic symptoms such as altered mental status, hypotension, or signs of sepsis (Williams et al., 2020).

**Thrombosis Prevention**

The risk of thrombotic complications can be mitigated through appropriate prophylactic measures. For patients at high risk, anticoagulation therapy may be considered, particularly in those with underlying myeloproliferative neoplasms or other thrombophilic conditions (Kumar et al., 2019).

Platelet monitoring is important in the postoperative period, as reactive

thrombocytosis commonly occurs following splenectomy and may contribute to thrombotic risk. Platelet counts typically peak 7-21 days postoperatively and may remain elevated for several months (Foster et al., 2018).

### Outcomes and Prognosis

#### Perioperative Outcomes

Contemporary series report low morbidity and mortality rates for splenectomy in patients with hematological malignancies, particularly when performed using minimally invasive techniques. Laparoscopic splenectomy is associated with conversion rates of 5-15%, with bleeding being the most common reason for conversion to open surgery (Romano et al., 2018).

Hospital length of stay is typically 2-4 days for laparoscopic procedures and 5-7 days for open procedures, though this may be extended in patients with underlying hematological conditions or postoperative complications (Chen et al., 2020). Return to normal activities typically occurs within 2-4 weeks for laparoscopic surgery and 4-6 weeks for open surgery.

#### Disease-Specific Outcomes

The impact of splenectomy on disease-specific outcomes varies significantly depending on the underlying hematological malignancy. For hairy cell leukemia, splenectomy can provide excellent long-term disease control, particularly in patients who are refractory to or intolerant of purine analog therapy (Grever et al., 2021).

In chronic lymphocytic leukemia, splenectomy may provide symptomatic relief and improvement in cytopenias, though it does not significantly impact overall survival in most patients (Hallek et al., 2018). For primary splenic lymphomas, splenectomy may be curative for localized disease, with 5-year survival rates exceeding 80% in appropriate candidates (Arcaini et al., 2020).

#### Quality of Life Considerations

Splenectomy can significantly improve quality of life in patients with symptomatic splenomegaly by relieving mechanical symptoms such as early satiety, abdominal fullness, and discomfort. Patients often report improved appetite and weight gain following surgery (Morrison et al., 2019).

However, the long-term implications of asplenia, including increased infection risk and need for ongoing medical surveillance, may impact quality of life. Patient education and appropriate follow-up care are essential to optimize long-term outcomes (Stevens et al., 2021).

### Future Directions and Innovations

#### Minimally Invasive Techniques

Continued refinements in minimally invasive surgical techniques, including single-incision laparoscopic surgery (SILS) and natural orifice transluminal endoscopic surgery (NOTES), may further reduce surgical morbidity. However, these techniques remain investigational and require validation in larger series (Barbaros et al., 2019).

Robotic surgery continues to evolve, with newer platforms offering improved ergonomics and cost-effectiveness. As technology advances and costs decrease, robotic splenectomy may become more widely adopted, particularly for complex cases (Ielpo et al., 2020).

#### Pathological Innovations

Advances in molecular pathology, including next-generation sequencing and digital pathology, are revolutionizing the diagnosis and classification of hematological malignancies. These technologies may provide more precise prognostic information and guide targeted therapy selection (Rosenquist et al., 2017).

Artificial intelligence and machine learning applications in pathology may enhance diagnostic accuracy and reduce interpretation variability. However, these technologies require extensive validation before routine clinical implementation (Echle et al., 2021).

#### Alternative Therapeutic Approaches

The development of targeted therapies for hematological malignancies may reduce the need for splenectomy in some conditions. For example, BTK inhibitors have shown efficacy in chronic lymphocytic leukemia and may reduce spleen size and associated symptoms without the need for surgical intervention (Byrd et al., 2018).

Splenic irradiation represents an alternative to splenectomy for selected patients who are not surgical candidates. While associated with its own risks and limitations, radiation therapy may provide symptomatic relief in patients with massive splenomegaly (Turner et al., 2019).

## CONCLUSION

Splenectomy remains an important therapeutic intervention in the management of various hematological malignancies, serving diagnostic, therapeutic, and palliative roles. The evolution toward minimally invasive surgical techniques has significantly improved perioperative outcomes while maintaining oncological efficacy. Laparoscopic splenectomy has emerged as the preferred approach for most patients, offering reduced morbidity and faster recovery compared to open surgery.

The success of splenectomy in hematological malignancies depends not only on appropriate surgical technique selection but also on comprehensive pathological evaluation. Modern pathological assessment extends beyond traditional morphology to include immunohistochemical, flow cytometric, and molecular analyses, which are essential for accurate diagnosis and treatment planning. This integrated approach requires close collaboration between surgical, hematological, and pathological specialists.

Postoperative management must address the unique challenges faced by patients with hematological malignancies, including increased infection risk, thrombotic complications, and ongoing disease management. Long-term follow-up and patient education are essential components of care to optimize outcomes and quality of life.

Future developments in surgical technique, pathological assessment, and targeted therapies will continue to refine the role of splenectomy in hematological malignancies. The integration of these advances with multidisciplinary care will further improve outcomes for patients requiring splenic intervention as part of their comprehensive cancer treatment.

As the field continues to evolve, ongoing research and clinical trials will help define optimal patient selection criteria, surgical approaches, and perioperative management strategies. The goal remains to provide patients with the most effective treatment while minimizing morbidity and preserving quality of life.

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