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Recommendations for gross examination and sampling of surgical specimens of the spleen☆

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ABSTRACT

This review examines handling and processing of spleen biopsies and splenectomy specimens with the aim of providing the pathologist with guidance in optimizing examination and diagnosis of splenic disorders. It also offers recommendations as to relevant reporting factors in gross examination, which may guide diagnostic workup. The role of splenic needle biopsies is discussed. The International Spleen Consortium is a group dedicated to promoting education and research on the anatomy, physiology, and pathology of the spleen. In keeping with these goals, we have undertaken to provide guidelines for gross examination, sectioning, and sampling of spleen tissue to optimize diagnosis (Burke [1]). The pathology of the spleen may be complicated in routine practice due to a number of factors. Among these are lack of familiarity with lesions, complex histopathology, mimicry within several types of lesions, and overall rarity. To optimize diagnosis, appropriate handling and processing of splenic tissue are crucial. The importance of complete and accurate clinical history cannot be overstated. In many cases, significant clinical history such as previous lymphoproliferative disorders, hematologic disorders, trauma, etc, can provide important information to guide the evaluation of spleen specimens. Clinical information helps plan for appropriate processing of the spleen specimen. The pathologist should encourage surgical colleagues, who typically provide the specimens, to include as much clinical information as possible.

1. Types of splenic specimens

There are different procedures that are performed to obtain splenic tissue (Table 1). Total splenectomy is performed to remove an intact spleen (Fig. 1A). Partial or segmental therapeutic splenectomy is performed in the pediatric age group, and the spleen is often removed along with tissue from other anatomic sites. The spleen can be removed by laparoscopically, yielding numerous tissue fragments. Formalin fixation occurs more quickly on the fragmented splenic tissue (Fig. 1B). Needle core biopsy of the spleen and fine needle aspiration/biopsy can also provide tissue for examination [2-5]. These 2 techniques are often not performed in North America except for biopsying clinically unexplained solid or cystic tumor masses. In other parts of the world, core needle biopsy and fine needle aspiration/biopsy are more commonly performed.

Splenectomy is a significant surgical procedure with numerous immunologic and hematologic consequences for the patient. Splenectomies are most commonly performed for therapeutic purposes [6]. One

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Table 1
Types of splenic specimens.

Procedures for splenic specimens	Comments
Open splenectomy	Removes intact spleen with hilar tissues
Partial or segmental splenectomy	Part of spleen removed ± tissue from other organs (ie, pancreatectomy or duodenopancreatectomy)
Laparoscopic splenectomy	Morcellated spleen is removed
Needle core biopsy of spleen	More common in countries outside United States
Fine needle aspiration of spleen	More common in countries outside United States

of the most common therapeutic indications for splenectomy is control of splenic hemorrhage secondary to blunt trauma or incidental intraoperative trauma. It is important to note that traumatic splenic injury is increasingly managed nonoperatively, leading to recently decreasing splenectomy rates for this indication. Splenectomy is occasionally required in the unlikely event of "spontaneous" or nontraumatic splenic rupture, associated with a broad range of etiologies (Table 2) [6-14]. Frequently, nontraumatic splenic rupture occurs secondary to acute infectious mononucleosis [8,13]. In this condition, infection by Epstein-Barr virus (EBV) leads to rapid expansion of the spleen, resulting in stretching and friability of the splenic capsule. Rupture can occur after even minimal trauma to the abdomen, especially the left upper quadrant.

Therapeutic indications for splenectomy also include cure or palliation of hematologic disease (eg, cytopenia secondary to idiopathic thrombocytopenic purpura and hemolytic anemia) and palliation of refractory cytopenia(s) due to hypersplenism—a condition in which there is excessive removal of hematopoietic elements by the spleen [15,16]. Splenectomies are also sometimes performed to palliate symptomatic splenomegaly (eg, abdominal pain from mass effect).

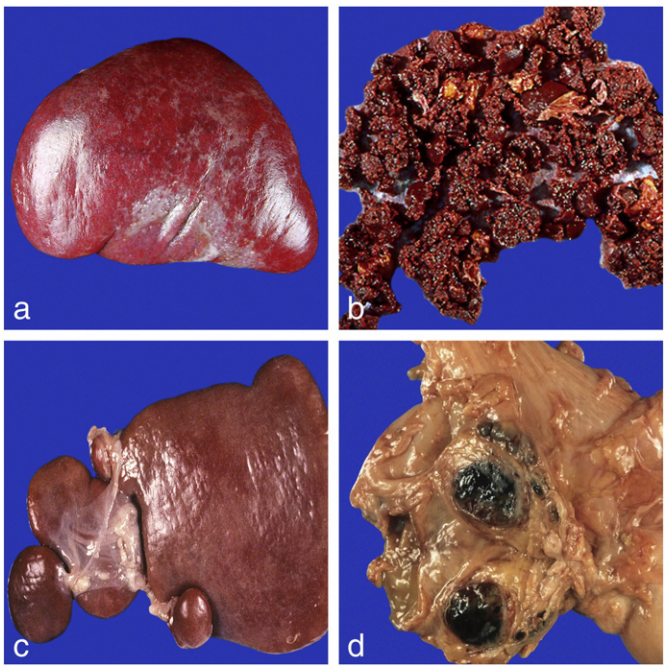

Fig. 1. Splenectomy. Gross image of the normal spleen from a total splenectomy shows a thick shimmering smooth intact capsule and mottled gray-red surface without any abnormalities (A). Morcellated spleen removed by laparoscopic splenectomy. Although the spleen is fragmented, there is usually enough tissue for accurate pathologic diagnosis (B). Polysplenia. Splenectomy specimen with polysplenia contains several splenic lobes separated by fibrous bands. Polysplenia can be associated with other congenital abnormalities (C). Splenosis. The beefy red nodules in this stomach represent splenic implants, known as splenosis. Splenosis results from injury of surgery but is not congenital, which distinguished it from accessory spleen (D).

Table 2
"Spontaneous[a]" splenic rupture: associations and etiologies.

"Spontaneous" Splenic Rupture
I. Infectious
a. Bacterial
i. Typhoid fever
ii. Q fever
iii. Infectious endocarditis (various species)
iv. Tuberculosis and other mycobacteria
v. Numerous others
b. Viral
i. Epstein-Barr virus
ii. CMV
iii. HIV
iv. Others
c. Parasitic/protozoal
i. Malaria
ii. Others
II. Hematopoietic diseases
a. Acute leukemias
b. Lymphoma/lymphoid leukemias
c. Myeloma/amyloidosis (especially plasma cell leukemia)
d. Chronic myelogenous leukemia and other myeloproliferative neoplasms
III. Vascular lesions
a. Benign (eg, peliosis, hemangioma)
b. Neoplastic (eg, littoral cell angioma, angiosarcoma)
IV. Cysts
V. Infarction
VI. Autoimmune including collagen-vascular diseases
VII. Hamartoma
VIII. Medications
a. Anticoagulants and thrombolytics
b. Cytokines including G-/GM-CSF
IX. Metastatic malignancy (carcinoma, melanoma, etc)
X. Storage diseases
XI. Coagulation abnormalities/hemoglobinopathies
a. Factor VIII deficiency
b. Congenital dysfibrinogenemia
XII. Pregnancy related
a. Postpartum
b. Ectopic pregnancy ("splenic" pregnancy)
XIII. Miscellaneous
a. Sarcoidosis
b. Acute pancreatitis
c. Cirrhosis of liver from any cause
d. Mechanical (after vomiting, coughing)

Abbreviations: CMV, cytomegalovirus; HIV, human immunodeficiency virus; G-CSF, granulocyte colony stimulating factor; GM-CSF, granulocyte macrophage colony-stimulating factors.
[a] This may be better referred to as "atraumatic" splenic rupture, as *spontaneous rupture* is sometimes defined as rupture associated with no specific underlying etiology.

In addition to these therapeutic indications, splenectomies are often performed for diagnostic purposes, namely, in the setting of diffuse unexplained splenomegaly or discrete mass lesions, which have been identified by radiologic studies [6]. Approximately 75% of these cases prove to be malignant neoplasms [17]. Splenectomy may be used to establish a diagnosis of lymphoma in the absence of more easily accessible tissue but is no longer indicated for staging lymphomas. Finally, the incidental removal of spleen may occasionally accompany surgical procedures such as a distal pancreatectomy.

Postmortem spleens should be evaluated in similar ways to those reviewed as surgical specimens. In a postmortem spleen, gross examination and evaluation of sections specimens will suggest the necessity of sampling for microscopic evaluation. Placing portions of spleen in fixative will limit the amount of autolysis encountered.

2. Gross evaluation of the external surface of the spleen

Before evaluation of a spleen specimen, available clinical history should be reviewed. This may give specific indications for evaluation and may provide guidance in sampling and evaluation. The gross evaluation of spleen must include identification and adequate sampling of pathologic processes. It is important to attempt to evaluate the specimen when fresh, as soon as possible. This will allow for optimal