The spleen and indications for splenectomy

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Abstract
Traditionally, the spleen has been surgically removed with little understanding of the potential consequences; this contribution explains the anatomical relations and numerous functions of the spleen and the potential complications following such an excision. Splenectomy may be undertaken as an emergency or electively; the indications and techniques are discussed, including the increasing use of minimally-invasive surgery and splenic conservation in the emergency setting. Postoperative care and the investigation and treatment of complications are also stated. Ongoing medical care of asplenic patients is considered with the aid of conclusions of the most recent Working Party on the subject.

Keywords spleen; laparoscopic; splenectomy; splenic prophylaxis

Surgical excision of the spleen (splenectomy) may be done electively (usually laparoscopically) or as an emergency (usually ‘open’ surgery); the latter is usually due to blunt trauma to the abdomen (see Garner, CROSS REFERENCES). Knowledge of the anatomical relations and functions of the spleen, and the potential complications and consequences of its excision, is important. The elective patient should be counselled about the consequences of splenectomy. Splenic preservation should be considered if it is safe and feasible.

Anatomy
The spleen is the largest single mass of lymphoid tissue in the body and is deep in the left hypochondrium (see ‘Anatomy of the pancreas’, page 72). It is covered anteriorly by the left costal margin, lying along the axis of the ninth/tenth ribs. The healthy spleen is the size of a closed fist and is not palpable on clinical examination. Hypertrophy of the organ can occur in disease states and enlargement is seen in an inferior and medial direction, towards the umbilicus and right iliac fossa. In general, the organ is ovoid in shape, with a convex lateral surface fitting the diaphragm (which it abuts) and a concave medial surface, at the centre of which is the splenic hilum. The spleen is invested in peritoneum, which maintains its position in the left upper quadrant. The peritoneum around the spleen helps to attach the organ to the upper posterior abdominal wall and it becomes condensed in certain areas, forming the ligaments through which the organ receives its blood supply. It is also closely related to many important structures within the abdomen (stomach, pancreas, kidney, splenic flexure of the colon) and good anatomical knowledge is essential to reduce surgical complications.

The gastroepiploic ligament passes from the greater curvature of the stomach to the spleen and contains the vascular supply and drainage of the spleen, principally the main splenic artery and vein and the short gastric vessels. The splenic artery arises from the coeliac trunk, passing behind the pancreas towards the splenic hilum, giving off the short gastric vessels to the gastric fundus and the left gastroepiploic artery supplying the greater curve of the stomach before entering the splenic substance. The splenic vein receives blood from the spleen and stomach via short gastric and left gastroepiploic veins. The venous drainage of the spleen is via the portal system as the splenic vein, having received the inferior mesenteric vein, joins the superior mesenteric vein to form the portal vein; this fact has important ramifications for surgery in patients with portosystemic hypertension (see Mirza, CROSS REFERENCES). The lienorenal ligament attaches the spleen to the tail of the pancreas and the kidney. Accessory spleens/splenunculi are relatively common (5–15%) and are often found in the lienorenal or gastroepiploic ligaments. The surgeon must be aware of the potential existence and the likely anatomical location of splenunculi because they may alter the outcome of splenectomy (particularly in patients undergoing surgery with immunological diseases). Congenital absence of the spleen is extremely rare.

Structure
The spleen is a reddish, firm organ weighing between 100 g and 200 g possessing an obvious capsule and significant supply of blood. Macroscopically, the cut surface of the organ reveals a ‘red pulp’, within which are scattered numerous white nodules (‘white pulp’). At the hilum, the fibrous capsule becomes condensed into strands or trabeculae, which accompany the vessels into the organ. The vessels divide into smaller arterioles that enter the substance of the spleen, entering sinusoids that are surrounded by numerous immunologically active cells. Here, filtration of the blood occurs as cells squeeze between the sieve-like network of the splenic cords (see below).

Functions
Blood filtration and immune responses are intimately related. The splenic cords are formed by reticular cells, plasma cells, phagocytes and B-lymphocytes, producing a sieve-like structure through which blood cells and foreign antigens must squeeze. The immunologically active cells in these sieves are activated by foreign antigens, and they mount an antibody response (particularly to encapsulated bacteria). The spleen produces opsonins (substances that bind to the foreign antigen, enhancing their uptake and phagocytosis by macrophages). The B-lymphocytes within the germinal centres are also sites for antibody production after activation by foreign antigens. The relatively recent realization of this important

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immunological function of the spleen has promoted the desire for splenic preservation.

**Blood sequestration:** damaged cells are recognized in the splenic cords and are phagocytosed, removing them from the circulation. Certain inclusion bodies within red cells are removed by macrophages without damage to the erythrocyte:
- Howell–Jolly bodies (remnants of nuclear DNA)
- Heinz bodies (denatured haemoglobin)
- siderotic granules (iron).

**Haemopoiesis:** the production of blood cells by the spleen is restricted to the first five months of intrauterine life (see Lewis, CROSS REFERENCES). The spleen retains a haemopoietic role in some disease states.

**Iron reutilization and reservoir function:** erythrocytes and the other cellular components of blood have a defined lifespan. As red cells age, membrane proteins become damaged; the cell becomes more ovoid and unable to deform in a manner that allows passage through the spleen. The spleen is the site of phagocytosis of these senescent cells and the iron liberated from the haem portion of the cell is reused. Initially, it is stored as haemosiderin in macrophages and is then transported to the bone marrow for reutilization in haemoglobin production bound to transferrin. In some mammals (particularly dogs), the spleen can act as a blood reservoir; the capsule and trabeculae which conduct the vessels through the organ have smooth muscle which can contract, discharging blood from the spleen into the circulation. A large quantity (litres) of blood can be sequestered in patients with significant splenomegaly. Human spleens do not usually sequester many erythrocytes, though it is a significant store for granulocytes and platelets. Excision of the spleen is often associated with a postoperative increase in circulating white cells and platelets, but not red cells.

**Indications for splenectomy (Table 1)**

**Traumatic injury to the spleen:** the spleen is the organ most at risk of damage after blunt trauma to the abdomen, yet fewer than 10% of patients require a laparotomy. Most patients who require splenectomy after trauma have sustained blunt injury to the left upper quadrant of the abdomen or left costal margin. Children are at greater risk of splenic rupture, as well as patients with pathological splenomegaly (Table 2) who may have life-threatening haemorrhage even after apparently trivial trauma. Malaria is the commonest cause of splenomegaly worldwide. In the emergency situation, trauma patients should be treated in accordance with the ABC principles of the Advanced Trauma and Life Support™ (see Hassan, CROSS REFERENCES). Unstable patients with abdominal distension, peritonitis and hypotension despite fluid resuscitation require transfer to the Operating Suite for an emergency laparotomy. Many patients become haemodynamically stable after resuscitation and a more conservative approach should be taken, allowing time for cross-sectional imaging. CT is very sensitive and specific for splenic injuries. In haemodynamically stable patients, it is more likely that a subcapsular splenic haematoma is formed rather than a free rupture into the peritoneal cavity (Figure 1). Many of these patients (65–95% of adults and 87–98% of children) can be treated conservatively. Close observation is imperative because secondary haemorrhage or continual slow ooze affects some patients, prompting a laparotomy. For patients treated conservatively, it is unclear for what length of time hospital observation is required. The authors’ institution observes patients for seven days post-injury because life-threatening haemorrhage from splenic injury has been noted up to this time. Documented series of splenic trauma note that most patients with delayed haemorrhage declare themselves within 72 hours.

**Haematological indications:** the spleen is responsible for the degradation of red blood cells (see page 57) when they reach the end of their functional life (about 120 days). In a number of conditions (hereditary spherocytosis, elliptocytosis), red cell morphology is altered such that the cells are unable to pass through the spleen and are phagocytosed in large quantities, causing anaemia and splenomegaly. Splenectomy relieves the excessive degradation of red cells and reduces the requirement for blood transfusion (although this does not correct the underlying defect of the red cell membrane). Autoimmune haemolytic anaemia and pyruvate kinase deficiency are other relative indications for splenectomy.

**Immune thrombocytopenia** is the commonest haematological indication for elective splenectomy. Excessive destruction of platelets due to synthesis of antiplatelet antibody within the spleen can lead to low concentrations of platelets such that spontaneous bleeding can occur, though more common symptoms are easy bruising, purpura, epistaxis and menorrhagia.

Initial treatment of such patients is corticosteroid therapy; 20% have a complete response requiring no further treatment. For most patients, repeat doses of corticosteroids and, in some cases, gammaglobulin therapy is required. Patients with refractory
thrombocytopenia may benefit from splenectomy. Laparoscopic splenectomy is the ‘gold standard’ for elective removal of normal and moderately enlarged spleens.

Neoplasia: splenectomy was previously undertaken to aid staging of haematological malignancies (e.g. lymphomas, leukaemias), but modern cross-sectional imaging has made such surgery redundant (although resection of the spleen is sometimes done for symptomatic reasons (pain) or to ameliorate the hypersplenism associated with an enlarged organ). Splenectomy may be the only way to achieve accurate tissue diagnosis and the optimum chemotherapeutic regimen devised. Overall, resection of the spleen for neoplasia has declined markedly in recent years. Massively enlarged spleens (i.e. chronic lymphocytic leukaemia) should be treated by open splenectomy.

**Splenectomy: surgical techniques**

**Open splenectomy**

Immediate resuscitation and rapid transfer to the operating theatre is necessary to control haemorrhage if the patient is haemodynamically unstable. Patients are placed in a supine, crucifix position on the operating table to allow optimal venous and arterial access for monitoring and fluid replacement. Placement of a nasogastric tube and urinary catheter should be undertaken if the general condition allows. An upper midline incision (see Ellis, *CROSS REFERENCES*) is done and the abdominal viscera and liver examined. If there is massive bleeding from the splenic region, the organ is brought forward and medially by dividing the diaphragmatic attachments of the spleen, followed by ligation of the vessels at the splenic hilum. In less urgent situations, the spleen is packed while the other abdominal viscera (particularly the liver) are inspected. The splenic vein and artery are divided between ligatures once haemorrhage is controlled. The short gastric vessels are treated similarly. Once the spleen is removed, care is taken to avoid haemorrhage from the splenic bed and also the tail of the pancreas, which is intimately related to the splenic hilum. A drain is often placed up to the left upper quadrant after surgery.

**Laparoscopic splenectomy**

Minimally-invasive splenectomy was first described in 1991 and was followed by a rapid expansion in the number of splenectomies carried out in this manner. Randomized controlled studies comparing open surgery with the laparoscopic approach have not been undertaken, but many surgeons believe the minimally-invasive approach is the ‘gold standard’.

The patient is placed in a right-lateral decubitus position with the left arm elevated; the position is maintained with lateral supports or pneumatic devices. A 30° laparoscope placed via the umbilicus and three further ports are usually sufficient (Figure 2). The lateral position allows the spleen to ‘hang down’ from its diaphragmatic attachments to allow access to the hilar vessels. The inferior pole and vessels are ligated, allowing exposure of the hilar vessels, which can be divided using a laparoscopic linear stapler. The short gastric vessels can be taken in a similar manner and the diaphragmatic attachments of the spleen are divided. Once detached, the spleen is placed in a retrieval bag and removed through the umbilical incision. The organ is often too large for direct extraction through the umbilicus and requires digital fragmentation of the parenchyma (within the bag) before removal from the peritoneal cavity.

A number of series of laparoscopic splenectomy have been published, with encouraging results in terms of patient recovery and complications. These studies indicate that larger spleens (usually ≥1 kg) are associated with an increased incidence of

### Causes of splenomegaly

**Infection**
- Acute (viral)
- Subacute
- Chronic (malaria)

**Immunological inflammatory disorders**
- Felty syndrome (with rheumatoid arthritis and granulocytopenia)
- Systemic lupus erythematosus
- Sarcoidosis
- Amyloidosis
- Thyroiditis

**Haemolytic anaemia**

**Immune thrombocytopenia**

**Portal hypertension**
- Thrombosis of the portal vein
- Liver cirrhosis

**Primary metastatic neoplasms**
- Leukaemia (in particular, chronic lymphocytic leukaemia)
- Lymphoma/Hodgkin’s disease
- Myeloproliferative syndromes
- Sarcoma

**Storage diseases**
- Gaucher’s disease
- Niemann–Pick disease

Table 2
conversion to open surgery. Patients should be counselled regarding the likelihood of conversion to open splenectomy if the spleen is palpable at the level of the umbilicus.

Complications of splenectomy

Haemorrhage is the most life-threatening complication; it usually occurs within the first 24 hours postoperatively and close observation during this period is essential.

Gastric dilation is a rare, but entirely preventable, complication thought to be due to the manipulation of the stomach during splenectomy. Placement of a nasogastric tube during surgery can prevent this complication in most cases.

Pancreatic fistula: trauma to the pancreas after splenic surgery is a risk due to the close proximity of the structure to the spleen. The amylase content of drain fluid should be measured if this is suspected.

Subphrenic abscess: removal of the spleen from the splenic bed can allow the formation of a collection of serosanguinous fluid that may become infected. Whether drains prevent such complications is controversial. A postoperative swinging pyrexia may indicate subphrenic abscess, which should be managed with a combination of imaging and drainage under radiological guidance.

Overwhelming post-splenectomy infection: the importance of the spleen in the immune system was recognized in the 1950s when a number of patients died from overwhelming sepsis after splenectomy. Patients undergoing this procedure are at particular risk of serious infection from encapsulated bacteria such as Streptococcus pneumoniae, Neisseria meningitides, Escherichia coli and Haemophilus influenzae. The commonest organism responsible for this syndrome is Streptococcus pneumoniae.

Immunization and antibiotic prophylaxis

Vaccinations
- Pneumococcal vaccination before surgery and repeated at intervals of five years
- *Haemophilus influenzae* and meningococcal vaccination before surgery if not previously received
- Influenza vaccinations given every year
- Giving vaccines minimum of two weeks before surgery or as soon as possible after emergency surgery

Antibiotics
- Lifelong penicillin should be offered (250–500 mg b.d.)
- Urgent admission to hospital and antibiotic administration on development of infective symptoms
- Written patient information and a health alert card

The most vulnerable are:
- children and elderly patients
- those in the first year after splenectomy
- those with haematological disease or malignancy.

In 2002, a working party of the Clinical Haematology Task Force produced revised standards in an attempt to reduce the incidence of overwhelming post-splenectomy infection. (Table 3). Asplenic patients include those in whom the spleen has been removed or who have undergone autosplenectomy from microvascular occlusion (sickle cell disease) or splenic atrophy (from coeliac disease). Patients should be told about the increased risk of contracting malaria from travel to areas where it is endemic.

REFERENCE


CROSS REFERENCES

Ellis H. Anatomy of abdominal incisions. Surgical and clinical anatomy for the MRCS examination. [www.surgeryjournal.co.uk](http://www.surgeryjournal.co.uk)


FURTHER READING