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# The Spleen Works as Two Organs

Research Article

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## Abstract

The spleen products, monitors, stores and destroys blood cells. It is located in the upper abdomen on the left side just below the chest. The spleen works as two organs. White pulp is part of the system that fights infection, and red pulp removes unwanted material from the blood, such as damaged red blood cells.

**Keywords:** Spleen; Abnormality; Injury; Splenectomy; Pain.

### Introduction

The spleen is principally situated within the left hypochondriac region of the abdomen, but its posterior end extends into the epigastric region [1]. It lies between the fundus of the stomach and therefore the diaphragm. The spleen is sort of entirely surrounded by peritoneum, which is firmly adherent to its capsule. To perform operations on the spleen one must have a transparent conception of the peritoneal folds, which are associated with the spleen. The spleen develops within the upper a part of the dorsal mesogastrium and remains connected with the stomach and also the posterior wall by two folds of peritoneum. The latter, termed lienorenal ligament, consists of two layers of peritoneum where the wall of the final peritoneal cavity comes connected with the omental bursa between the left kidney and spleen. The splenic vessels and sometimes a portion of the tail of the pancreas lie between its two layers. the former fold, termed gastrosplenic ligament, also consists of two layers and is additionally formed by the meeting of the walls of the greater sac and omental bursa between the stomach and therefore the spleen. The short gastric and left gastroepiploic vessels run between its two layers. The lateral end of the spleen is in touch with phrenico–colic ligament. Accessory Spleen (Splenunculi).—These are small encapsulated nodules of splenic tissue, which are developmentally segregated from the most spleen and are found mostly (i) in touch with the spleen near its hilum, (ii) in gastro–splenic ligament, (iii) in lienorenal ligament in relation with the splenic vessels and (iv) within the greater omentum, mesentery, mesocolon and near left testis or ovary. These are functionally similar to the spleen and while performing splenectomy for blood dyscrasias removal of those accessory spleens are obligatory, otherwise there always remains an opportunity of recurrence.

### Anatomy

For its size, the spleen is very well perfused [2]. It is a soft lymphatic organ and contains about 1/4 of the body's total lymphoid tissue, but unlike the lymph nodes, it is integrated into the blood instead of lymphatic circulatory system. The hilum of the spleen is found roughly within the middle of the visceral surface, where the branches of the splenic artery enter and also the tributaries of the splenic vein leave. This can be the only place where it's not covered by the peritoneum. The spleen is suspended within the left upper quadrant by the splenophrenic, gastrosplenic and splenocolic ligaments; its physiological position and its shape can vary consistent with the position and distension of the neighbouring organs and also the position of the body.

Generally the artery has one branch each to the upper and lower poles and itself enters the spleen within the middle of the hilum in order that the spleen may be divided into three segments: upper, middle and lower. These segments are quite autonomous in their arterial and venous circulation. The segments are superposed perpendicularly along the long axis of the spleen and are separated by poorly vascularised planes. The splenic branches are considered to be nonanastomosing terminal arteries, aside from some intrahilar shunts; there are some intersegmental vessels that allow subtotal permeation of the segments with a rise in pressure. Intersegmental connections allow ligature of the most vessel or a catheter embolisation, which is sometimes be tolerated without total necrosis. Because of these poorly vascularised intersegmental zones, the spleen may be partially resected with minimal blood loss.

Based on the distribution of blood vessels within the splenic parenchyma, we distinguish between a central zone near the hilum, a peripheral zone distant from the hilum and an intermediate zone between the two. Understanding these zones of vascularisation is very important for classifying the severity of splenic injuries, particularly intraoperative injuries. An intraoperative injury that involves only peripheral (subcapsular) parenchyma opens the peripheral arterioles and venous sinuses. The trabecular vessels are affected within the intermediate area. Parenchymal injuries of the medial surface penetrating into the central zone often damage the segmental vessels. Surgical measures are determined by the nature and degree of vascular injuries.

### Abnormality

Abnormal and aged erythrocytes, abnormal granulocytes, normal and abnormal platelets and cellular debris are cleared by the spleen [1]. The abnormally shaped or rigid red cells are

destroyed by culling. Culling refers to filtering and phagocyiosis of old red blood cells which have either been damaged or are abnormally shaped or contain abnormal inclusions e.g. nuclei, nuclear remnants (Howell–Jolly bodies). It also removes spherocytes, siderocytes and target cells. Normal red cells usually traverse the splenic circulation and will undergo 'repair' by having surface abnormalities like pits or spurs removed. Reticulocytes pass through the spleen more slowly than mature red cells and lose nuclear membranes and excess membrane before entering the circulation as mature red cells. Spleen also removes certian inclusions by 'pitting'. Such inclusions could also be red cell nuclei or malarial parasites without destroying the red cells. These 'cleaned' red cells ultimately pass through the splenic circulation and re–enter the blood stream. Only the aged red cells (more than 120 days) that have lost membrane plasticity and enzymatic activity are destroyed within the spleen. Blood cells coated with immunoglobulin g (IgG) are destroyed by the splenic monocytes. because the spleen removes cells coated with IgG or IgM, it's the location of destruction in diseases e.g. autoimmune haemolytic anaemia, idiopathic thrombocytopaenic purpura or probably Felty's syndrome. Overactivity of splenic function resulting in accelerated removal of any or all of the circulating cellular elements of the blood, which can result anaemia, leucopenia, or thrombocytopenia, is known as hypersplenism. the normal red cell possesses a life span of approximately 120 days which isn't prolonged after splenectomy. that means there are other sites of red cell destruction.

## Injury

Many Class II and III articles with prospective observation and retrospective analysis are written purporting the security of selective nonoperative management in penetrating abdominal wounds [3]. These articles stress that the best candidate for nonoperative management of penetrating wounds to the abdomen is hemodynamically stable, without peritonitis, and have a reliable clinical exam. In–house surgical staff are required to perform serial clinical exams and detect a change in condition directly. These studies also validate computed tomography (CT) scan as a comprehensive means for diagnosis and follow–up.

However, when the spleen is involved in a penetrating injury, the end result for salvage isn't promising. Demetriades published a prospective observational study on selective nonoperative management of patients with penetrating abdominal solid organ injury. This protocol–driven study included immediate laparotomy for patients with hemodynamic instability, peritonitis, unreliable abdominal exam, or CT scan indicative of hollow organ injury. Only one of the 28 patients with penetrating splenic injuries had successful nonoperative management.

## Palpation

An enlarged spleen appears below the tip of the tenth rib along a line heading towards the umbilicus and, if really large, may extend into the right iliac fossa [4]. A normal spleen isn't palpable.

To feel the spleen, place the fingertips of your right hand on the right iliac fossa just under the umbilicus. Ask the patient to take a deep breath. If nothing abnormal is felt, move your hand in stages towards the tip of the left tenth rib. When the costal margin is reached, place your left hand round the lower left rib cage and lift the lower ribs and therefore the spleen forwards because the patient inspires. This manoeuvre occasionally lifts a rather enlarged spleen far enough forward to create it palpable.

The spleen is recognized by its shape and site and, when present, the notch on its supero–medial edge. It's dull to percussion because it lies immediately beneath the wall with no bowel ahead of it, unlike a renal mass.

## Management

The gold standard for blunt trauma abdominal evaluation within the stable patient is that the abdominal CT scan [3]. CT scan findings of contrast extravasation, pseudoaneurysm, or arteriovenous malformation increase the risk of failing nonoperative management 40–67%. Other CT scan findings indicative of failure include Grade III or higher injury and huge hemoperitoneum, which increase the risk 12–13%. Large hemoperitoneum is defined as abdominal free fluid extending from the splenic recess to the pelvis, whereas small and moderate hemoperitoneum is free fluid contained within the splenic recess and free fluid extending into the pericolic gutters. The therapeutic options for these findings are institutionally dependent and are discussed within the next sections concerning angiography and surveillance.

Associated injuries revealed by CT scan or physical exam were present in 52% of nonoperative failures, compared to twenty of successes. Management of associated injuries sometimes require interventions that preclude a reliable abdominal exam. There's no recent Class II or III article that studies this scenario in depth. Thus, it's up to the individual surgeon to stay the entire patient and injuries in mind when deciding the way to manage a splenic injury.

The management of older patients with splenic injuries has been the topic of debate in recent literature. Patients older than 55 have a 20–30% chance of failing nonoperative management. The morbidity of older patients who have successful nonoperative management is 8%, whereas younger patients have a mortality of 4%. For those patients over 55 who fail nonoperative management, the death rate was 29% compared to 12% of these younger than 55. In multiple studies, the cause of death within the elderly was thanks to associated injuries, like closed head injuries, multisystem organ failure, and acute respiratory distress syndrome. Elderly trauma patients as a population have higher mortality rate compare to those younger than 55. This was true whether they underwent nonoperative management or had immediate operative therapy. In fact, elderly patients who failed nonoperative management had a lower rate than those elderly patients who had immediate laparotomy.

Another indicator of failure for nonoperative management of blunt splenic injury is blood transfusions within the first 24 hours of presentation. Most nonoperative management protocols have a first 24–hour transfusion limit tat alerts physicians to ongoing bleeding. This was derived from the literature, which shows that patients who were successfully managed nonoperatively received a mean of 1.2–1.9 units of blood within the first 24 hours of presentation. people who received over 6 units had a statistically significant higher morbidity, incidence of splenectomy, and infectious complications.

## Resections

Necrosis confined to the stomach should prompt total gastrectomy; partial gastric resections should be avoided because ongoing necrosis might compromise outcomes [5]. Immediate

reconstruction by esophagojejunostomy (EJ) should be attempted if patient condition allows; esophageal exclusion or external drainage will be performed as a damage control strategy. EJ leakage during this setting (5–8%) is within the range of EJ failure rates reported after gastrectomy for cancer. Feeding jejunostomy should be constructed systematically as esophageal strictures develop in most patients.

Extended resections (beyond esophagogastrectomy) are required when caustic necrosis involves other abdominal organs. Concomitant resection of the spleen, the colon, the bowel, and of the duodeno–pancreas was reported in up to twenty you take care of patients who underwent OGT (Oesophagogastrectomy). Necrosis of the transverse colon is typically because of the direct extension of posterior gastric wall injuries to the mesocolon. Transmural duodenal necrosis is sometimes managed by pancreatoduodenectomy (PD), although the pancreatic parenchyma is seldom involved. If the patient condition allows, immediate pancreato–biliary reconstruction is usually recommended. Bowel necrosis is typically associated with intraluminal passage of caustic agent; massive bowel necrosis contraindicates resection thanks to poor patient survival and compromised nutritional and reconstructive issues. All obvious transmural necrosis injuries should be resected during the initial procedure; second–look procedures should be reserved to rare situations when ongoing necrosis is suspected.

## Splenectomy

Even though several splenic salvage operations exist, in a very surgically complex patient where a second physiological insult may prove fatal, a splenectomy is that the safest and of course the only reasonable operative option [6]. Splenorrhaphy and other MESH maneuvers to salvage the spleen is also considered in relatively stable, healthier, younger patients.

The most important principles governing a splenectomy are exposure, mobilization, and control of hilar vessels. A midline incision and self–retaining retractors assure exposure. The surgeon may evacuate the blood within the left upper quadrant and pack laparotomy pads round the spleen. If needed, the remainder of the abdomen may be quickly and systematically explored at this point in order to rule out the other injuries. within the current scenario, it'll be important to rule out other hollow viscous injuries because the spleen is in close proximity to the stomach and enormous and little bowels. To aide with exposure packs are often placed behind the spleen/under the diaphragm—this will elevate the spleen to bring it into view. All four ligaments attaching the spleen to stomach (splenogastric), diaphragm (splenophrenic), kidney (splenorenal), and colon (splenocolic) have to be taken down. Care should be taken while dissecting the splenogastric ligament and therefore the short gastric vessels should be appropriately controlled. within the above–mentioned patient, a prior gastric pull up operation would have already divided the short gastric vessels. Adhesions from the prior operation have to be carefully dissected, traction on the spleen should be gentle to avoid capsular avulsion. If the previously placed jejunostomy feeding tube is hindering the operation, then this tube should be removed and replaced at the tip of the procedure. Once the spleen is mobilized and elevated to the central aspect of the surgical field, the hilum is exposed and therefore the artery and also the vein should be individually ligated near the hilum. The surgeon should be aware that the splenic artery may begin to branch up to five cm before entering the hilum and these branches should be ligated additionally. Drains are placed providing there's suspected injury to the tail of the pancreas during mobilization and dissection. The splenic bed is usually vascular and may be a source of extravasation, and this will be prevented with the employment of argon beam to the splenic bed. Once the spleen is removed, the abdomen is enclosed the quality fashion and standard postoperative care must ensue, including 24–h perioperative antibiotics, venousthromboembolism prophylaxis, incentive spirometry, pain control, fluid, and acid base management. Appropriate vaccinations should be administered after 2 weeks or before discharge as is typical for an unpredictable splenectomy.

## Diaphragm

Diaphragm could be a curved musculature which separates thoracic from abdominal cavity [7]. Ruptured diaphragm represents less than 1% of traumatic injuries, usually related to motor vehicle crashes, trauma, falls, and crush injuries. penetrating injury to the abdomen or chest from the level of T4 to T12 anteriorly and L3 posteriorly could lead on to diaphragmatic injury. 88–95% of diaphragmatic injuries occur on the left side, including spleen injury.

Apart from severe chest or abdominal pain, clinical features may vary based on the mechanism of injury. Ruptured diaphragm is sometimes related to severe trauma including injuries of other surrounding thoracic organs, like lungs, heart, or abdominal organs like spleen, stomach, liver. Patients with diaphragmatic injury may present with respiratory distress, dyspnea, orthopnea, and cough. Severe herniation occurs when spleen is injured, whereas tachycardia and signs of intestinal obstruction or sepsis within the abdomen is also present. Clinical examination shows absent or reduced breath sounds within the affected chest area. Bowel sounds could also be present just in case of bowel displacement into the thoracic cavity. Tympanic or dull sounds could also be present during percussion in cases where intestines or liver migrate, respectively, within the thoracic cavity.

Chest X–ray has low sensitivity and specifcity since other injuries like pulmonary contusion, hemothorax, or pneumothorax could also be present, masking the injury on the x–ray film. Chest X–ray fndings may reveal the presence of air bubbles within the affected hemithorax. Mediastinum may appear shifted toward the opposite side, while the diaphragm may appear beyond normal because of the presence of stomach within the left hemithorax. CT scan is considered because the gold standard technique since it offers an exact evaluation of the size and location of the diaphragmatic rapture.

## Abdominal Pain

Left upper quadrant abdominal pain is less common and has fewer causes than other regions of the abdomen [8]. Pancreatitis can present with isolated left upper quadrant pain or in conjunction with epigastric or right upper quadrant pain. Peptic ulcers are much rarer within the fundus and cardia, which are located within the left upper quadrant, but still can occur. Pathology involving the spleen like abscess, infarct, or rupture can cause severe left upper quadrant pain. Rupture of the spleen is most often thanks to trauma but can occur spontaneously from splenic enlargement seen with portal hypertension or lymphoma. Infarcts of the spleen can occur in patients with sickle–cell anemia, generally in their youth, or in patients with hypercoagulable disorders. Splenic aneurysms can rupture and result in intraperitoneal hemorrhage,

a disease entity more commonly problematic in pregnant patients. Splenic flexure colorectal adenocarcinoma can result in acute abdominal pain, generally once the mass has grown to a critical size causing obstruction.

Right lower quadrant abdominal pain could be a common presenting complaint for patients, most frequently because of appendicitis. Appendicitis can initially present with periumbilical pain that migrates to the correct lower quadrant, classically with pain over McBurney's point, or two–thirds of the way between the umbilicus and therefore the anterior superior iliac spine. The pain are often related to fevers together with nausea, vomiting, and anorexia that classically occur after the pain starts. Although appendicitis may be a quite common entity seen because the reason behind acute abdominal pain within the right lower quadrant, there are a myriad of other causes that the surgeon must take into consideration and rule out before proceeding with operative management for appendicitis. Crohn's disease flares commonly occur within the distal ileum and might present with very similar symptoms and imaging showing inflammation similar to appendicitis. Meckel's diverticulum could be a remnant of the omphalomesenteric duct and it occurs in about 2% of the population. This diverticulum is found within the distal ileum and might become inflamed resulting in acute right lower quadrant pain. Sigmoid diverticulitis may present with right lower quadrant pain within the patient with a redundant sigmoid. Urogenital disease processes like pyelonephritis, perinephric abscess, urolithiasis, or urinary tract infections can all cause right lower quadrant pain. In female patients, gynecologic causes of right lower quadrant pain must even be excluded. For all female patients of childbearing age, pregnancy testing must always be a part of the workup for any abdominal pain to rule out ectopic pregnancy, which may be a surgical emergency. This information is additionally critical because it could significantly alter the medical and/or surgical approach to the pathology responsible for the abdominal pain. Other gynecologic causes include ruptured follicular or corpus luteum cyst, ovarian torsion, pelvic inflammatory disease, or salpingitis. Infectious causes like viral gastroenteritis, Yersinia infections, and mesenteric adenitis can all mimic appendicitis with acute right lower quadrant abdominal pain. wall defects, like ventral and inguinal hernias, can even cause acute onset of abdominal pain during this region if intestinal contents become incarcerated or strangulated within the hernia.

## CT

CT using thin collimation and thin reconstruction images (1– to 2–mm–thick slices) is that the imaging modality of choice within the evaluation of suspected diaphragmatic injury in patients with blunt or penetrating trauma [9]. Sagittal and coronal reformations are shown to increase sensitivity and confidence of interpretation. Sensitivities of 70–90% are reported.

A constellation of CT findings has been evaluated for the detection of diaphragmatic rupture. the foremost frequently cited are direct discontinuity or focal defect of the diaphragm, intrathoracic herniation of abdominal viscera, the collar sign, and therefore the dependent viscera sign. Visualization of a focal discontinuity of the diaphragm is 73–82% sensitive and 90% specific for diaphragmatic injury. Bochdalek hernias, focal defects within the posterolateral diaphragm, may mimic traumatic rupture and account for falsepositive findings. Intrathoracic herniation contains a sensitivity of 55–75% and a specificity of 100%. Waist–like constriction of herniated abdominal contents at the level of diaphragmatic rupture creates the collar sign, best depicted on coronal and sagittal reformations. With thin section helical CT, the collar sign has a sensitivity of 63% and a specificity of 100%. The dependent viscera sign describes the position of the stomach, spleen, or bowel that has herniated into the thorax and lies adjacent the dependent aspect of the chest wall. This sign yields sensitivity of 55–90% for blunt trauma diaphragmatic injuries. Other signs suggestive of diaphragmatic injury include thickening and segmental non–visualization of the diaphragm.

Penetrating diaphragm injuries tend to be considerably smaller than blunt diaphragmatic injuries, and accordingly radiologic signs based on the herniation of abdominal viscera are only occasionally helpful. Diagnosis depends on demonstration of a simple breach of the diaphragm. Direct visualization of the diaphragm defect on CT is specific but uncommonly seen. CT demonstration of contiguous injuries on both signs of the diaphragm is that the most sensitive CT finding and in many cases and its absence can be used to exclude injury. Unfortunately, its specificity will be diminished if multiple wounds are present. Construction of double oblique CT images along the trajectory of the knife or bullet (trajectography) can improve specificity of diagnosis. Demonstration of a tract extending on each side of the diaphragm is specific for penetrating diaphragm injury and in many cases is adequate impetus for operative exploration.

## Conclusion

The spleen is a spongy organ located below the left ribbed arch, built of white and red pulp. White pulp is actually lymph tissue that produces lymphocytes that travel to the bloodstream and serve to expel toxic and harmful substances from the body, while red pulp surrounds white pulp and because it is rich in blood and blood vessels has the function to break down bad red blood cells and purify blood. The spleen is actually a storehouse of red blood cells and platelets. The spleen also produces white blood cells, lymphocytes that, by removing harmful substances from the body, actually protect the body from infections. If an injury or disease of the spleen occurs, there are problems with the immune system and blood circulation, which can further cause diseases of the heart, lungs, brain and all organs in the body. One can live without a spleen although it must sometimes be removed due to life threatening. Nevertheless, it must be pointed out that it has an important function in the human body.

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## Conflict of interest

The author has no conflict of interest to declares.

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