

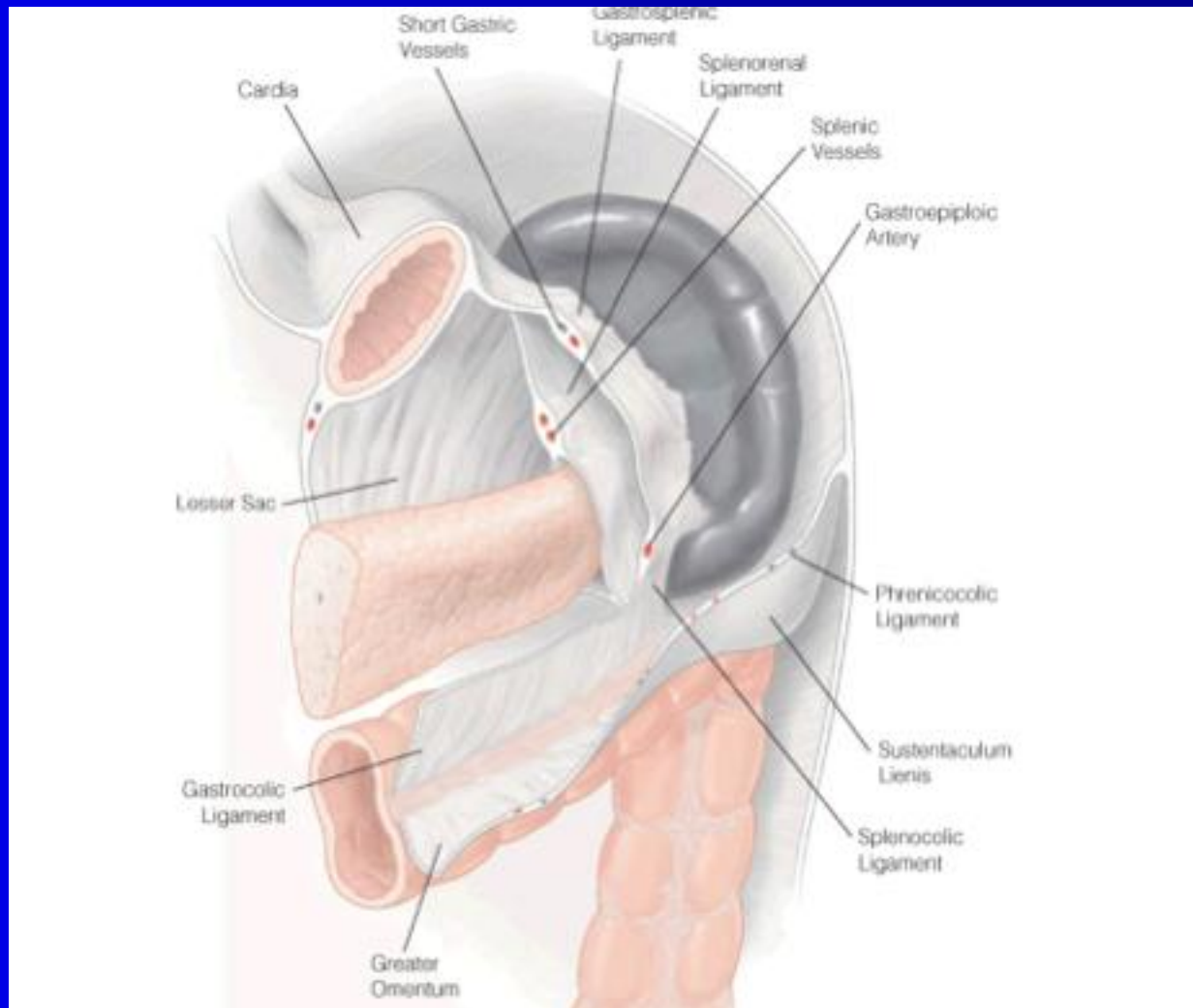
The Spleen

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Anatomy:

- Normal size: 12x7 cm, 3-4 cm thick, ~150 gm
- Parietal peritoneum adherent except at hilum
- Peritoneal extensions- 4 ligaments:
 - splenocolic, splenophrenic- relatively avascular
 - Splenorenal: splenic vessels, tail of pancreas
 - Gastrosplenic ligaments: short gastric vessels

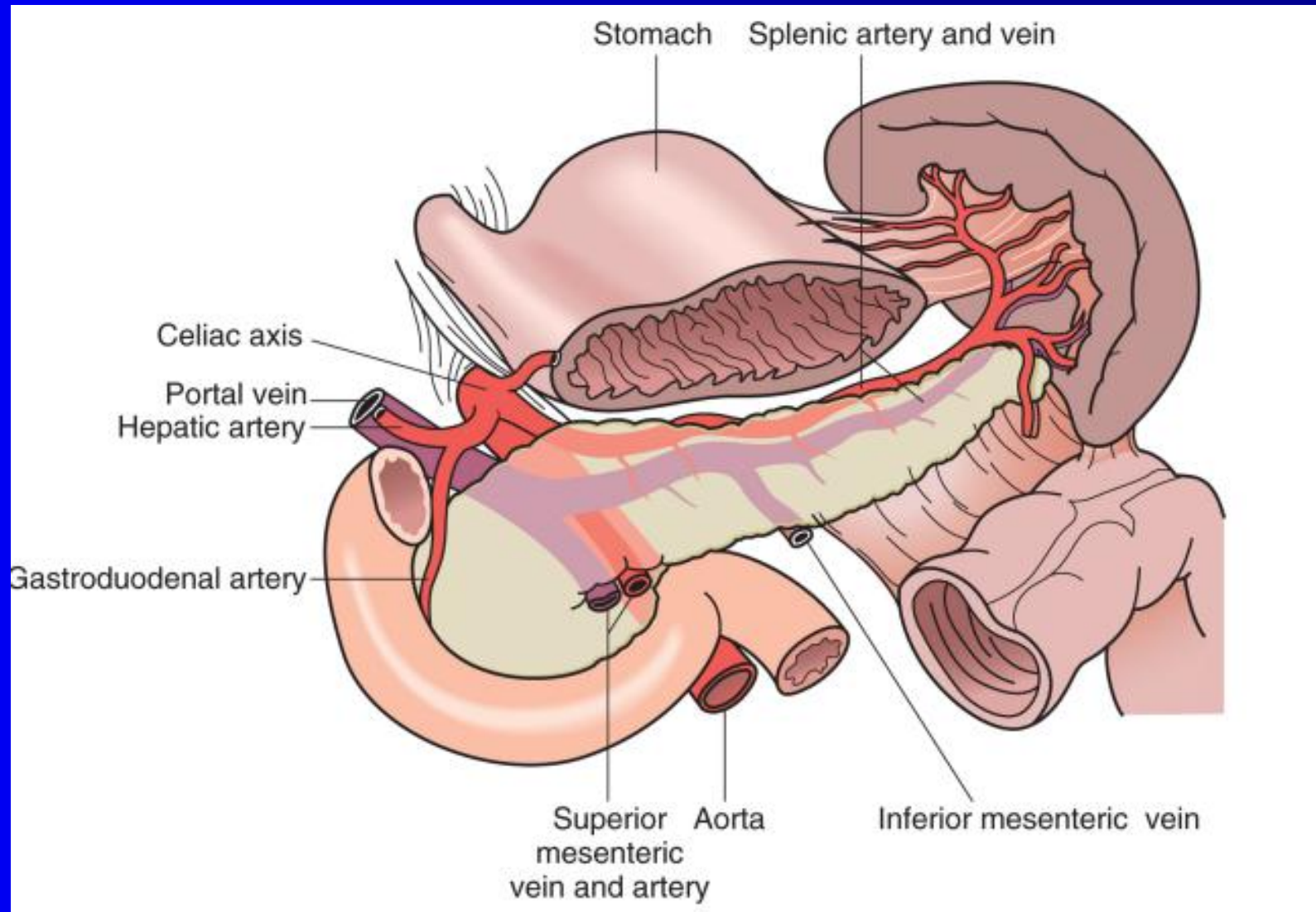
Anatomy continued:



Anatomy continued

- **Splenic artery:** off celiac trunk, multiple pancreatic branches, short gastrics, left gastroepiploic, terminal splenic branches-> segmental branches-> 2nd, 3rd order vessels
- Splenic vein:
 - Inferior to artery , posterior to pancreatic tail, body
 - Joins SMV behind pancreatic neck-> portal vein

Splenic Vasculature:



Splenic Function:

- Early hematopoiesis
- Mechanical filtration of senescent erythrocytes
- Infection control:
 - Pathogens within RBCs: Malaria, Bartonella
 - Clearance of unopsonized, noningested bacteria from circulation
 - Microorganisms without specific host antibody

Asplenia

- OPSI- overwhelming postsplenectomy sepsis:
Fulminant bacteremia, pneumonia, meningitis
- Organisms with polysaccharide capsule: Ab + complement activation
- Normal response to reimmunization
- Suboptimal response to new antigen
- Higher quantities of Ab for encapsulated bacteria
- Decreased levels of IgM
- Peripheral mononuclear cells have suppressed IgG response

Opsonins:

- Major production site
- Tuftsin:
 - Enhances phagocytic activity
 - Spleen : major cleavage site-> decreased neutrophil function
- Properdin: initiates alternative pathway of complement activation

Idiopathic thrombocytopenic purpura- ITP:

- low platelet count, normal bone marrow in absence of other causes of thrombocytopenia
- Autoantibody to Plt membrane Antigens-> phagocytosis , destruction
- 72% women >10 years
- 70% of affected women <40 yo
- Children:
 - both sexes equally affected
 - Abrupt onset of severe thrombocytopenia
 - 80% spontaneous remission
 - Chronic: girls >10yo

ITP: symptoms and diagnosis

- Symptoms:

- Purpura, epistaxis, gingival bleeding
- Less common: GI bleed, hematuria
- Rare: intracerebral hemorrhage

- Diagnosis of exclusion:

- Drugs
- HIV
- Myelodysplasia, CLL, NHL
- TTP
- Preeclampsia
- DIC

Indications for treatment of ITP:

- Platelet Count:
 - >50,000- no treatment
 - <50,000 – treatment if vigorous lifestyle, HTN, peptic ulcer disease
 - 30,000-50,000 no treatment, close observation
 - <20,000 hospitalization and glucocorticoids
 - All patients with severe hemorrhage : hospitalized and treated

Treatment of ITP:

1. Prednisone: 1mg/kg/day

-> 2/3 patients with Plts > 50,000 in 1 week

-> 26% complete response

2. IVIG: acute bleeding, preop, pregnancy

- 1g/kg x 2 days -> increases Plt count in 3 days

-> increases efficacy of transfused Plts

3. Splenectomy

Splenectomy for ITP:

- First effective treatment before glucocorticoid therapy-
> 2/3 patients complete response
- Indications:
 - Severe refractory thrombocytopenia: 6 wks of continued Plts <10,000
 - Toxic steroid dosing -> remission
 - Relapse after initial treatment: Plts <30,000 after transient or incomplete response over 3 months
 - Pregnancy:
2nd trimester, failed IVIG and steroid course
-> Plts<10,000 or <30,000 with bleeding

Response to splenectomy

- Systematic review of 436 articles from 1966-2004:
 - 66% complete and 88% partial response in adults-median F/U 29 months
 - 72% complete response in children and adults
 - 15% relapse- median F/U 33 months

Predictors of Successful Splenectomy

- No consistent factors
- Age, response to steroids - not a predictor
- Indium 111-platelet scintigraphy:
 - Splenic sequestration-> 87-93% response rate
 - Hepatic sequestration-> 7-30% response rate
 - > long term cure rates unchanged

ITP postsplenectomy:

- Response within 10 days postop
- Durable response: >50,000 on POD#3
>150,000 on POD#10
- Chronic ITP: ? Accessory spleen if unresponsive to continued treatment with steroids and azathioprine

Summary of splenectomy series:

- Laparoscopic splenectomy:
 - 85% immediate response
 - 4% relapse rate
 - 15% accessory spleen
- Open Splenectomy:
 - 81% immediate response
 - 12 % relapse rate
 - 16% accessory spleen

ITP and HIV

- 10-20% develop ITP
- Splenectomy safe
- No increased risk of disease progression
- Absence of spleen in asymptomatic phase of HIV may delay disease progression

Splenectomy for Benign Hematologic Conditions:

1. Hereditary spherocytosis:

- autosomal dominant spectrin deficiency-> small, spherical rigid erythrocytes
- anemia, jaundice, splenomegaly
- Attempt delay of splenectomy after age 4
- High incidence of gallstones: lap cholecystectomy

2. Other erythrocyte abnormalities: hereditary elliptocytosis, pyropoikilocytosis etc.

Splenectomy for Malignancies:

1. Hodgkins lymphoma:

- Decreased operative staging: improved imaging techniques: CT, lymphangiography, PET scan
- Periop mortality <1%, major complication<10%

2. Non-Hodgkins Lymphoma:

- Massive splenomegaly , abdominal pain fullness, early satiety
- Treatment of hypersplenism associated anemia, thrombocytopenia, neutropenia
- Improved survival for low grade NHL confined to spleen (108 versus 24 months)

Splenectomy for Malignancies:

3. Hairy Cell leukemia:

- splenectomy and Alpha – 2 interferon replaced by systemic purine analogues
- Hypersplenism refractive to medical therapy
- Response lasts ~10yrs without further treatment

4. CLL:

- Palliation of symptomatic splenomegaly- 100% success
- Treatment of cytopenia- 60-70% success

Splenectomy for Malignancies:

5. CML:

- Palliation of symptomatic splenomegaly and hypersplenism

6. Metastasis:

- Breast, lung, melanoma
- Vascular tumors
- Splenectomy for palliation if needed

Splenectomy for benign conditions:

1. Splenic cysts

a. True cysts:

- parasitic:
 - Hyatid cysts(ecchinococcus), splenectomy to avoid spillage
- nonparasitic:
 - 10% of all nonparacytic cysts, most often due to trauma
 - lined by squamous epithelium
 - Often positive for Ca 19-9, CEA, but benign
 - Symptoms related to size
 - Open or laparoscopic: partial splenectomy, cyst wall resection, partial decapsulation

Splenectomy for benign conditions:

- 1. Splenic cysts

- b. Pseudocysts:

- 70-80% of nonparasitic cysts;
 - History of trauma
 - Asymptomatic <4cm, no treatment
 - Left upper quadrant pain, referred shoulder pain-> partial splenectomy
 - 90% success rate of image-guided percutaneous drainage

Splenectomy for benign conditions:

2. Splenic Abscess:

- uncommon, potentially fatal
- 70% hematogenous spread: endocarditis, osteomyelitis, IVDU
- Multiple abscesses in immunocompromised patients
- Organisms: GPCs: strep, staph, enterococcus; GNR: enteric organisms; Mycobacteria; Fungal: candida-immunosuppression
- Symptoms: nonspecific abdominal pain, peritonitis, pleuritic chest pain
- Treatment: unilocular: CT-guided drainage, IV antibiotics
Multilocular+ failure of response: immediate splenectomy

Splenectomy for benign conditions:

3. Wandering Spleen:

- Failure of formation of peritoneal attachments
 - > unusually long splenic pedicle
- Recurrent episodes of abdominal pain from intermittent torsion of vascular pedicle and tension
- CT scan for diagnosis: lack of contrast enhancement
- Splenectomy versus splenopexy

Splenic Trauma:

- Most common indication for laparotomy after blunt trauma
- Most commonly injured abdominal organ in blunt trauma
- Mechanism:
 - MVC, MCC, falls, PVA, bicycle crashes, sports
 - Injuries :
rapid deceleration-> avulsion along ligaments
Efficient energy transfer from chest wall
Direct punctures from rib fracture

Diagnosis of Splenic Trauma:

1. Historically PE:
 - peritoneal signs (42-72% accurate)
 - Bruising over LUQ
 - Kehr sign: left upper quadrant pain, with referred left shoulder pain
 - Hypotension, tachycardia-> suspicious for hemorrhage, not attributed to other source
 - Confounding factors: head, spinal cord injury, substance abuse
 - West et al: development of trauma systems: mortality from delayed/missed recognition of splenic hemorrhage still major cause of preventable death

Diagnosis of Splenic Trauma cont:

2. DPL:

- Introduced in 1965 by Root
- standard of care for blunt abdominal trauma for 20 yrs
- Originally: 10ml blood aspirated=> +
- Now: 1L crystalloid infusion=> >100,000 RBCs, 500 WBCs
- Sensitivity: 99%, Specificity: 95-98%
- Drawback: “nontherapeutic laparotomies”

Diagnosis of Splenic Trauma cont:

3. CT scan: revolutionized management of splenic trauma=> Grading scale

Table 56-6 -- American Association for the Surgery of Trauma Splenic Injury Scale (1994 Revision)

GRADE	TYPE	INJURY DESCRIPTION
I	Hematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1 cm parenchymal depth
II	Hematoma	Subcapsular, 10%-50% surface area; intraparenchymal, <5 cm in diameter
	Laceration	Capsular tear, 1-3 cm parenchymal depth, which does not involve a trabecular vessel
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma
		Intraparenchymal hematoma >5 cm or expanding
	Laceration	>3 cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury which devascularizes spleen

Adapted from Moore EE, Cogbill TH, Jurkovich GJ, et al: Organ injury scaling: Spleen and liver (1994 revision). J Trauma 38:323, 1995.

Diagnosis of Splenic Trauma cont:

4. Ultrasound

- Introduced in 1990s
- FAST(focused abdominal sonogram for trauma):
 - noninvasive, rapid, low cost
 - Presence of intraperitoneal fluid, replaced DPL
- ⇒ OR without CT scan in unstable patient
- ⇒ stable patient: screening for CT scan
- Limited by obesity, bowel gas and subcutaneous emphysema
- Sensitivity: 90-93%, Specificity: 99%

Indications for Surgery:

- Urgent laparotomy for hemodynamic instability and ongoing hemorrhage:
 - SBP < 90 mmHg
 - HR > 120 beats/min
 - No response to 1-2L crystalloids
- Optimal decisions apparent in retrospect!
- Risks of prolonged hemorrhage outweigh risks of nontherapeutic laparotomy!

Trauma Exploration:

- Midline incision preferred
- Rapid evacuation of blood and clots to assess other sources of injury: liver, mesentery, abdominal packing
- Splenic mobilization:
 - dorsal and medial traction on spleen: => define splenorenal and splenophrenic ligament- divide under direct vision
 - Incision begins at phrenocolic ligament-> ligaments of stomach near highest short gastric vessel

Splenic mobilization:

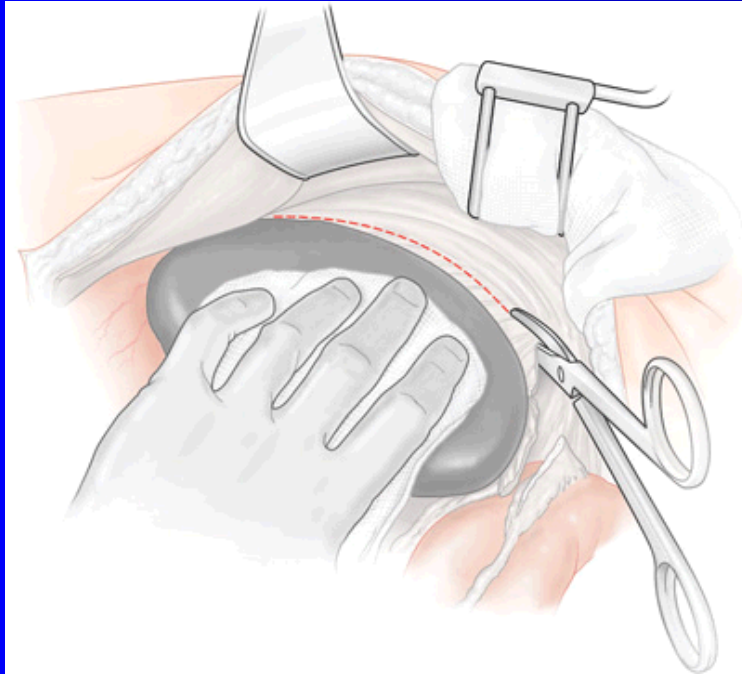


Figure 19. Open splenectomy: incision of phrenicocolic ligament. With the spleen retracted medially, the phrenicocolic ligament is incised.

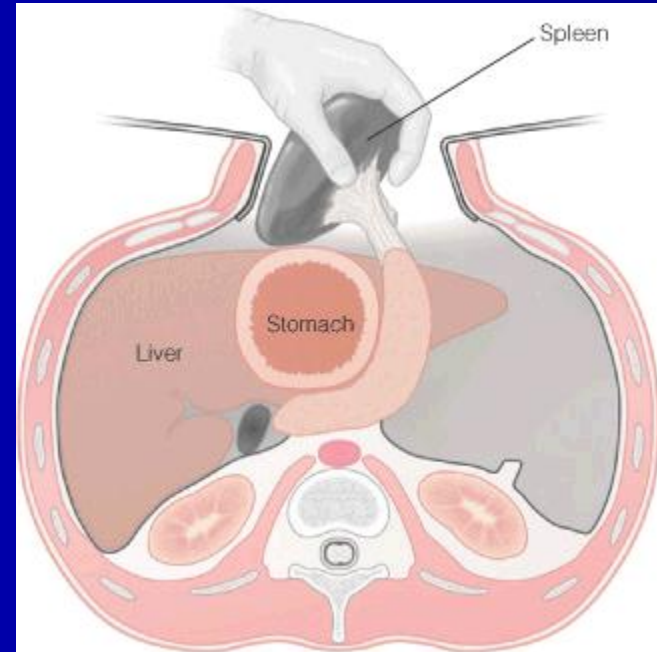


Figure 20. Open splenectomy: dissection of areolar plane. The spleen is delivered to the midline by means of blunt and sharp dissection of the areolar plane between the kidney and the pancreas.

Splenic mobilization continued:

- Continued tension-> divide deeper layers of connective tissue- > encounter adrenal, leave undisturbed
- Mobilize posterior pancreas complex: (pancreas + splenic vein) off aorta
- Pack LUQ to anteriorize spleen into wound
- Examine spleen

Splenectomy

- Indications:
 1. Unstable patient
 2. Extensive injury with continued bleeding
 3. Bleeding from hilar injury
 4. Other life threatening injuries
- Divide short gastrics- avoid injury to stomach
- Divide splenic artery + vein: avoid tail of pancreas
- No drain needed

Splenorrhaphy:

- Since late 1970s, peak in mid 1980s
 - Reasoning
 - Recognition of risk of OPSI with splenectomy
 - Left upper quadrant dead space: potential for subphrenic abscess
 - Decreased number of splenorrhaphies with rise in nonoperative management and awareness of risks of blood transfusions in 1990s
- => now 10%

Splenorrhaphy continued:

4 types:

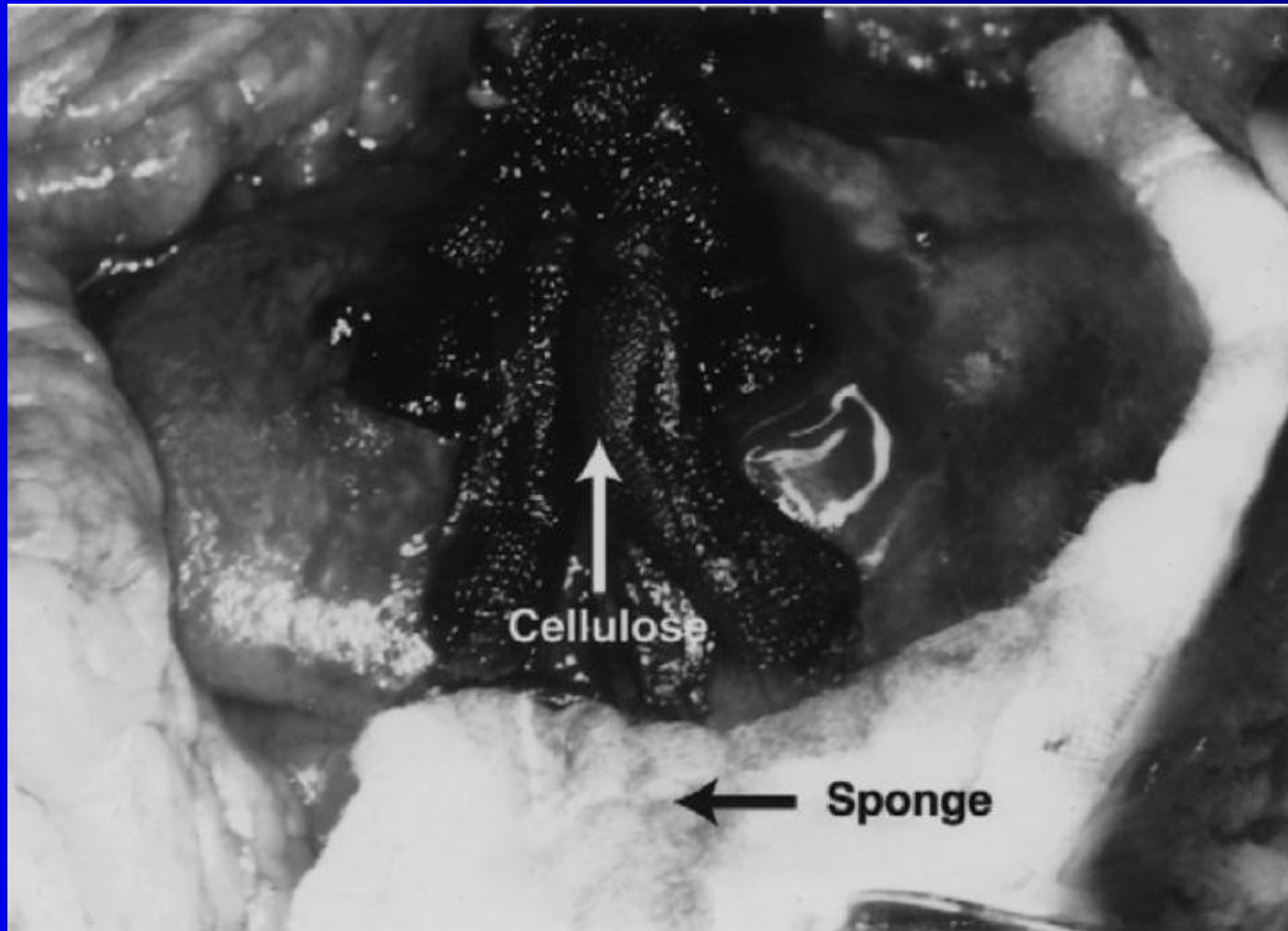
1. Superficial hemostatic agents:

- For grade I-II injuries: cautery, oxidized cellulose, topical thrombin, absorbable gelatin sponge

2. Suture repair:

- For grade II-III injuries
- Pledged sutures: telfon, absorbable gelatin sponge wrapped in oxidized cellulose

Suture Repair



Splenorrhaphy continued

3. Mesh Wrapping:

- Grade III and IV injuries
- Resorbable mesh: polyglycolic acid, polyglactin
- Keyhole at splenic hilum; mesh sac for spleen

4. Resectional debridement:

- Major fractures involving upper and lower pole=> grade II or IV
- Raw surfaces re-approximated
- 1/3 of splenic mass needed to maintain immunocompetence

Mesh Wrapping



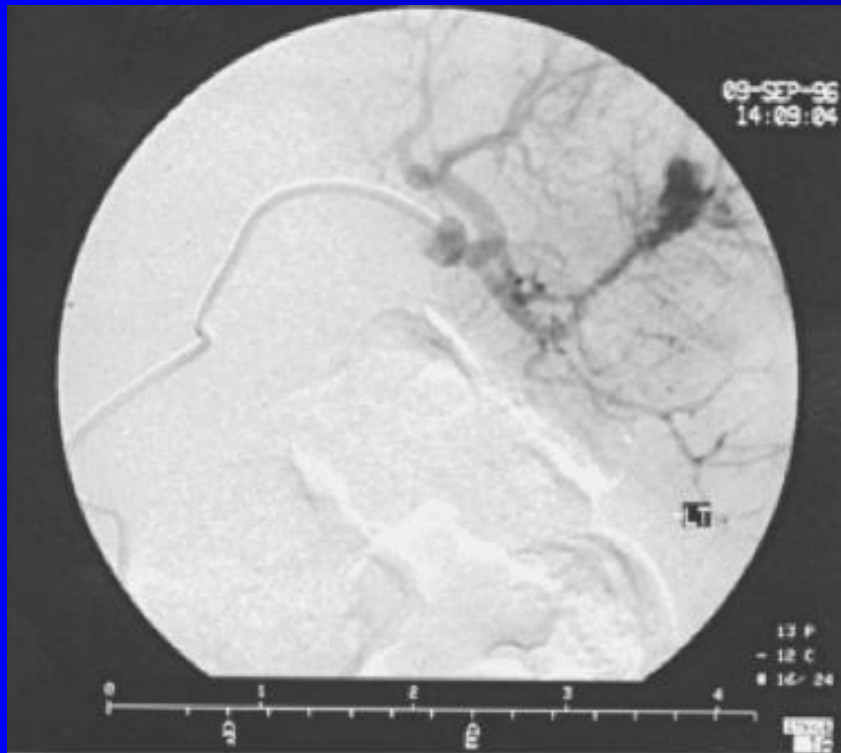
Nonoperative management:

- Originated in pediatric surgery with fear of OPSI
- 70-90% children, 40-50% adults treated in large volume trauma centers
- Fundamental rules: hemodynamic stability, adequate monitoring available
- Dependent on injury grade: I+II account for 60-70%

Nonoperative management:

- Failure of nonoperative management:
 - Vascular blush on CT scan:
2/3 failures related to pseudoaneurysms
Angiographic embolization reduces failure rate
 - Predictors of failure:
 - Age > 55
 - Higher injury grades: III-V
 - Amounts of intraperitoneal blood
 - Further studies needed

Vascular blush



Pre

-



Post- embolization

Summary: Management of Splenic Trauma

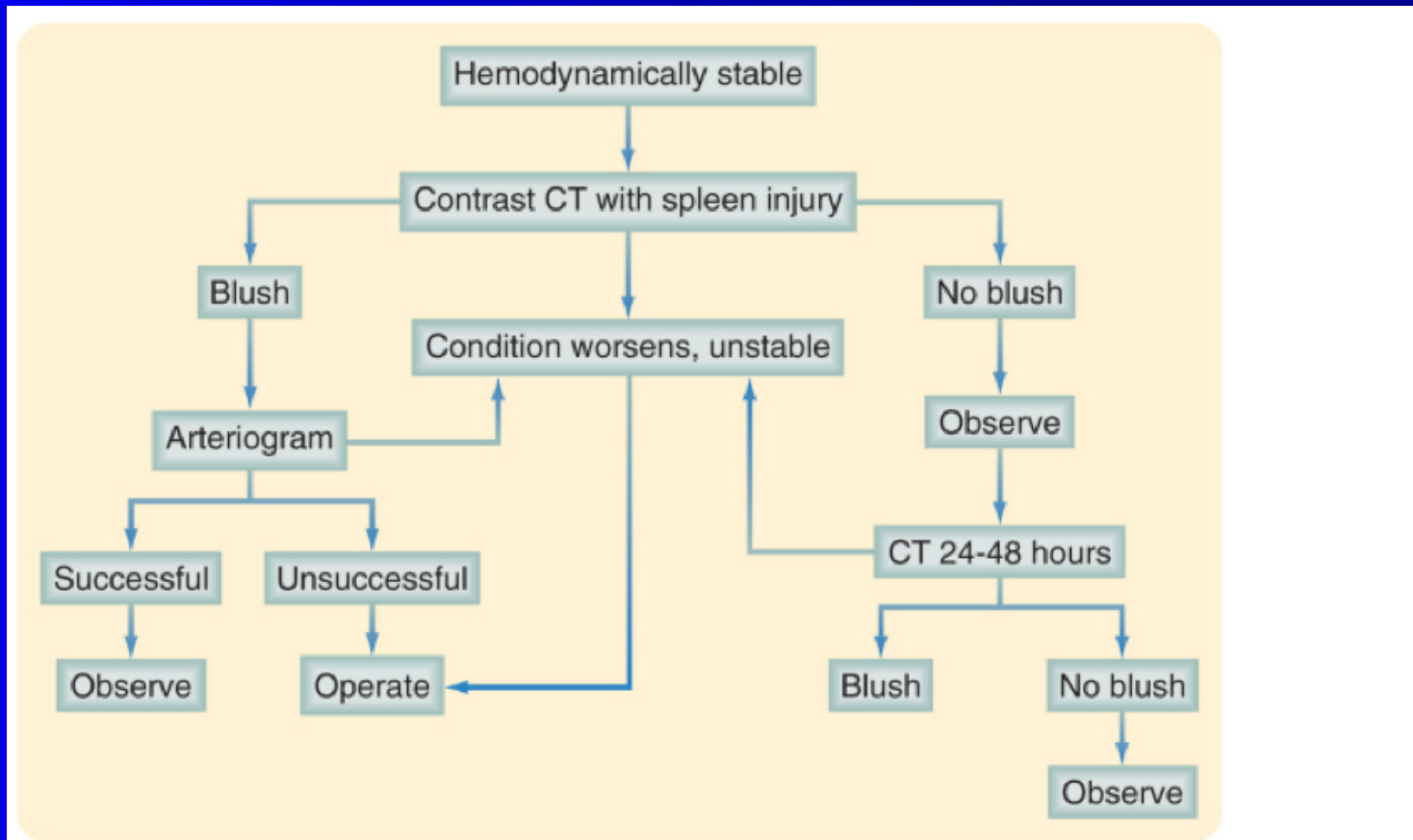


Figure 56-9 Algorithm for nonoperative management of splenic injuries in the hemodynamically stable patient. CT, computed tomography. (From Bee TK, Croce MA, Miller PR, et al: Failures of splenic nonoperative management: Is the glass half empty or half full? *J Trauma* 50:231, 2001.) www.lww.com

Morbidity after Splenectomy:

- Postsplenectomy thrombocytosis:
 - hemorrhagic or thromboembolic phenomena
 - Increased in patients with myeloproliferative DO
 - Life-long increased risk in pulmonary emboli
- OPSI:
 - Anytime after splenectomy
 - Lifetime increase in risk for fatal PNA, sepsis
 - Higher risk after splenectomy for malignancy
 - Higher risk in children (1:300) vs adults (1:800)

Morbidity after Splenectomy

- OPSI continued:
 - organisms: *S. pneumoniae* (50-90%), *H. Influenza*, *N Meningitis*, *Strepp sp*, *Salmonella*, *Capnocytophagia canimorsus* (dog bites)
- Prophylaxis:
 - Vaccines: PPV23 , *H. influenza* type B, meningococcal polysaccharide- within 2 weeks of surgery
 - Re-vaccination controversial except PPV23 for high risk patients

Morbidity after Splenectomy

- Antibiotics:

PCN prophylaxis in children common

No data on reduction of OPSI in adults or children

Early empiric coverage for febrile illness

- PATIENT EDUCATION about OPSI!

Thank You!