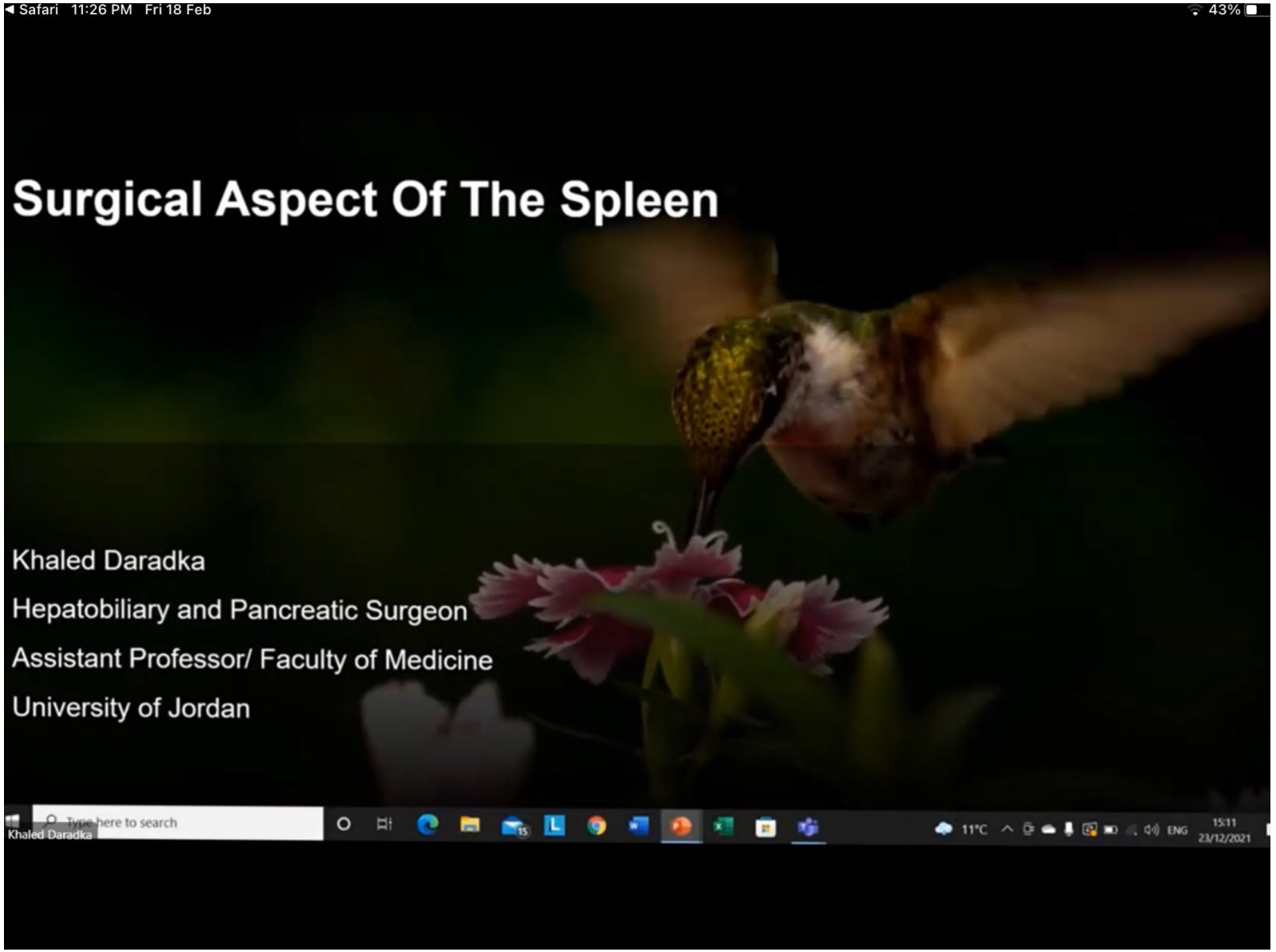


Properties of the Normal Spleen

The spleen (largest lymphopoitic organ) is located posterolaterally in the left upper quadrant of the abdomen

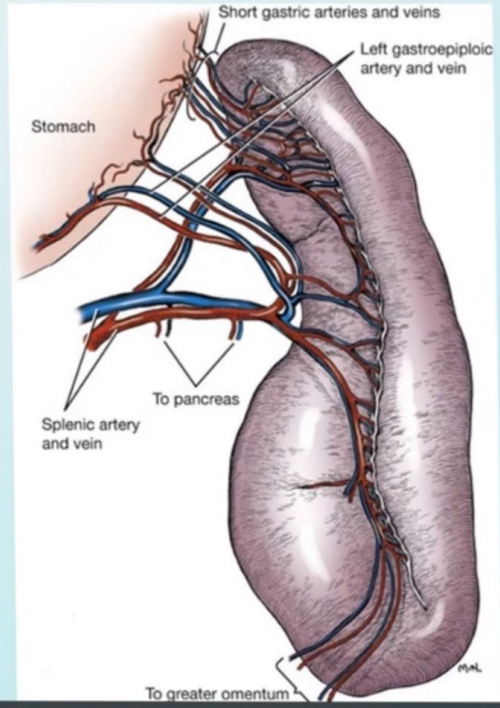
Through 9th to 11th rib

Fragile sponge-like organ

Thicker splenic capsules in children

The splenic artery, from the celiac artery

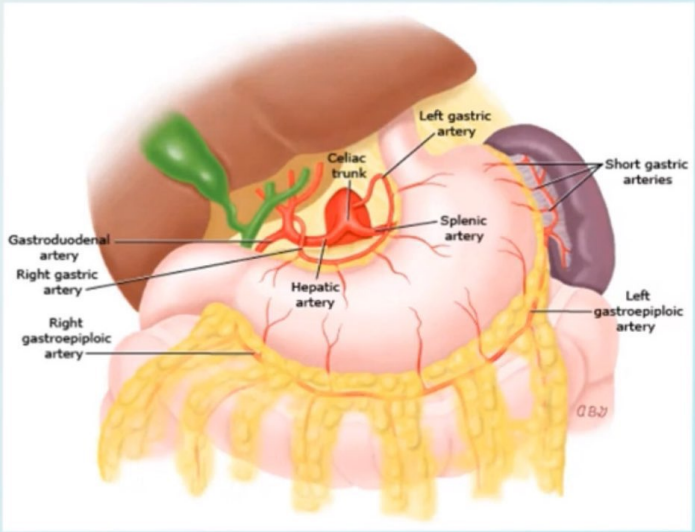
Three to seven segments, each with its own intraparenchymal **terminal vascular supply**



The size of the spleen correlates with a person's height, weight, and sex rule of the odd numbers

The spleen is attached to surrounding structures via four main ligaments.. the gastrosplenic and splenorenal, splenophrenic and spleno-colic ligaments

Involved in the antibody response against infection, most importantly for opsonization of encapsulated bacteria



Indications for Elective (nontraumatic) Splenectomy

Broadly include:

- Conditions with significant hemolysis or thrombocytopenia that depends on splenic function and/or autoantibody production
- Malignant or infectious disorders predominantly localized to the spleen
- Removal en bloc with other organs for cancer surgery
- Rare complications of other disorders in which there is massive splenomegaly and/or hypersplenism with cytopenias

Elective Splenectomy

Possibly indicated
Cancer surgery*
Felty syndrome
Hereditary spherocytosis
Immune thrombocytopenia (ITP)
Pyruvate kinase (PK) deficiency
Splenic abscess
Splenic marginal zone lymphoma
Splenic vein thrombosis with bleeding gastric varices
Splenomegaly (massive or symptomatic)
Transfusion-dependent thalassemia
Warm autoimmune hemolytic anemia (AIHA)

Rarely indicated
ABO or HLA desensitization for kidney transplant
Chronic lymphocytic leukemia (CLL)
Hairy cell leukemia
Primary myelofibrosis
Splenic infarction
Splenic sequestration crisis in sickle cell disease
Thrombotic thrombocytopenic purpura (TTP)

Preoperative Considerations

Vaccinations

Splenectomy increases the risk for serious, including life-threatening, infections, especially with encapsulated organisms such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis*.

A good immune response to most vaccines occurs within two weeks, Still ideal timing is 10 to 12 weeks

Annual influenza vaccination can reduce mortality from secondary bacterial infection

Optimizing haemoglobin and platelet count

VTE prophylaxis

Splenectomy carries a higher postoperative VTE risk than other types of major abdominal surgery ~10%

Surgical approach

Open versus laparoscopic procedure

Settings in which an open procedure may be preferred include the following:

- Massive splenomegaly
- Local expertise / lack of support or equipment for laparoscopy
- Ability to search more thoroughly for an accessory spleen
  - Splenectomy may be less effective therapeutically if the accessory spleen is not removed at the time of splenectomy, leading to recurrence of the underlying condition for which splenectomy was performed.
- Cancer surgery or adhesion of the spleen to adjacent organs requiring laparotomy

Background of splenic trauma

- The spleen and liver are the most commonly injured intra-abdominal organs following blunt trauma.
- Most commonly occurs following motor vehicle collisions.
- Also result from falls, sport-related activities, or assault
- Penetrating splenic trauma is less common
- Iatrogenic traumatic injuries can result from surgical or endoscopic manipulation of the colon, stomach, pancreas, kidney, or with exposure and reconstruction of the proximal abdominal aorta.
- **Kehr's sign** is pain referred to the left shoulder that worsens with inspiration and is due to irritation of the phrenic nerve from blood adjacent to the left hemidiaphragm

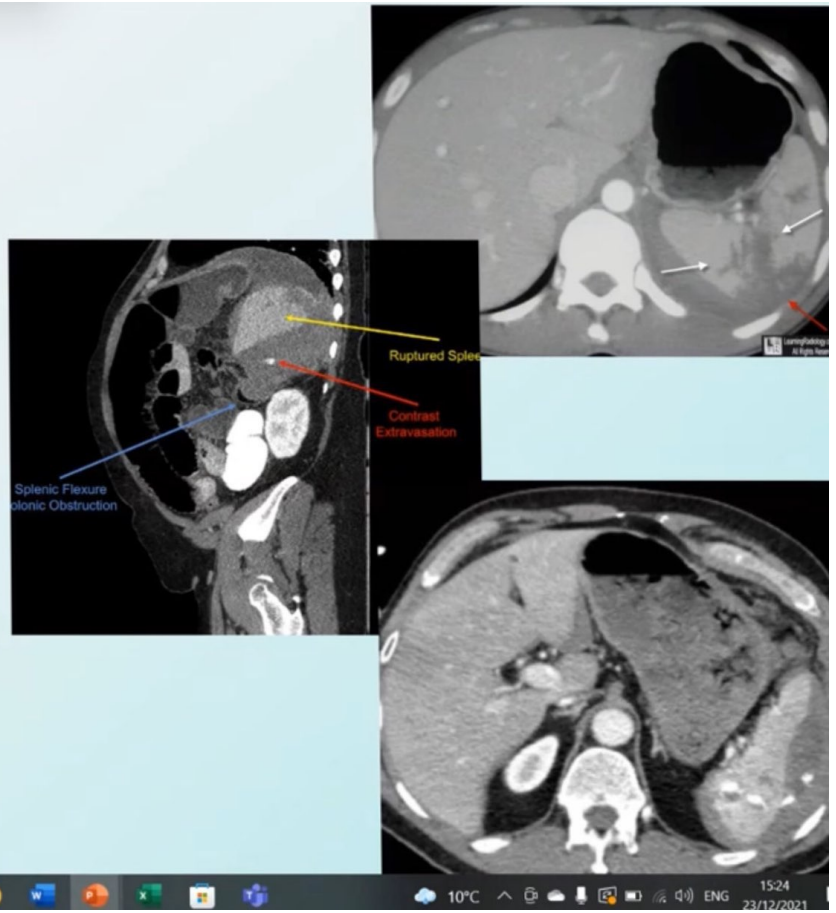
Diagnostic evaluation

FAST Exam

- Hypoechoic rim around the spleen

CT scan

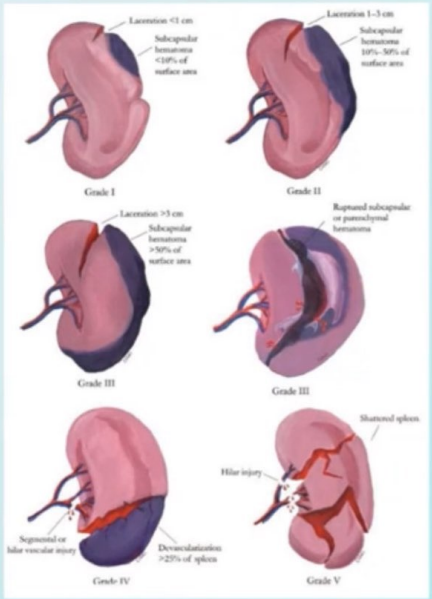
- Hemoperitoneum – Localized fluid collections around the spleen
- Hypodensity – Hypodense regions represent areas of parenchymal disruption, intraparenchymal hematoma, or subcapsular hematoma.
- Contrast blush or extravasation –represent traumatic disruption or pseudoaneurysm of the splenic vasculature.
- Active extravasation of contrast implies ongoing bleeding and the need for urgent intervention



American Association For The Surgery Of Trauma Organ Injury Scale

I	Hematoma Laceration	Subcapsular, <10% surface area Capsular tear, <1 cm parenchymal depth
II	Hematoma	Subcapsular, 10% to 50% surface area Intraparenchymal, <5 cm in diameter
	Laceration	Capsular tear, 1 cm to 3 cm parenchymal depth that does not involve a trabecular vessel
III	Hematoma	Subcapsular, >50% surface are 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 Vascular	Completely shattered spleen Hilar vascular injury with devascularizes spleen

Adapted from American Association for the Surgery of Trauma organ injury scale for spleen.



Management Approach

Non-operative management

NOM consists of close observation and monitoring, supplemented with splenic artery embolization if necessary

Any attempt to salvage the spleen (to preserve functional spleen) is abandoned in the face of ongoing hemorrhage or other life-threatening injuries

Emergent and urgent splenectomy remains a life-saving measure for many patients

General indications

Hemodynamic stability and absence of other abdominal organ injuries requiring surgery (peritonitis), **irrespective of injury grade**

An environment that provides capability for intensive monitoring, an immediately available OR and immediate access to blood and blood product

Splenic Artery Embolization

Distal (selective) Embolization

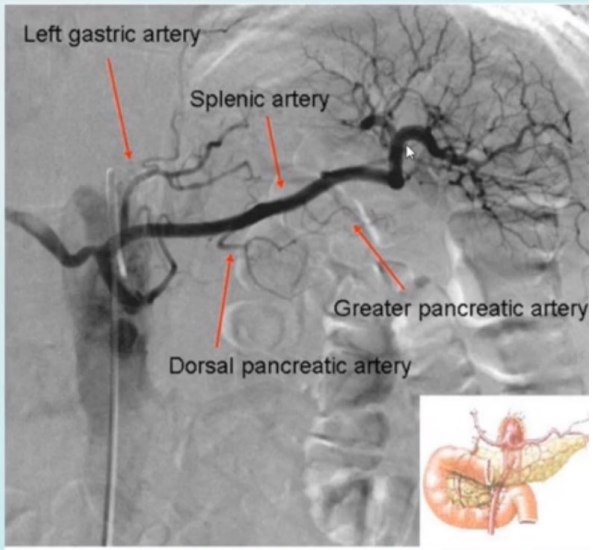
- Vascular injury such as contrast extravasation (blush), pseudoaneurysms
- As close as possible to the site of bleeding **in order to limit parenchymal infarction**

Proximal Embolization

- **Lowers distal systolic arterial pressure by 40 mm Hg** on average, enhancing the healing process

Preventive embolization seems to have potential in

- High-grade trauma (Splenectomy decreased by 16% to 18%)
- Patients who have high-risk prognosis factors



Risk Factors For Failure Of NOM

- Age
- Grade of injury and the quantity of hemoperitonmium
- Concomitant solid organ injury
- Vascular abnormality.. Contrast blushes.. Pseudoanurysms… A-V fistula…
- **None** has been shown to consistently predict success or failure of nonoperative management
- **Timing:**
- An observation period of five days identifies at least 95 percent of patients who would require some form of intervention
- The failure rate of NOM is around 10-15%

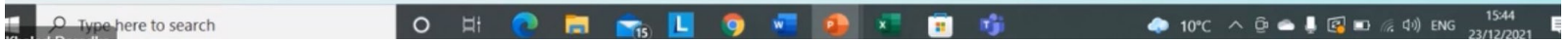
Pros and Cons of NOM

Advantages

- Preservation of functional spleen
- Overwhelming post-splenectomy infection
- Surgical risks and potenial complications
- Shorter hospitalisation period and a concomitant reduction in costs

Disadvantages

- Risk of delayed splenic rupture/ re-bleeding
- Increased risk of missed injuries (hallow viscus)
- Transfusion related complications
- SAE Risks if used:
  - Splenic infarction
  - Splenic/subdiaphragmatic abscess
  - Inadvertent embolization of other organs (eg, pancreas) or lower extremities
  - Allergic reaction to contrast
  - Contrast-induced renal insufficiency



Operative management

Indicated for the hemodynamically unstable trauma patient who has a positive focused assessment with sonography in trauma (FAST exam) or diagnostic peritoneal aspiration/lavage (DPA/DPL) to control life-threatening hemorrhage, which may be due to an injured spleen OR those who failed NOM

"Unstable" patient:

- Blood pressure < 90 mmHg and heart rate > 120 bpm
- Evidence of skin vasoconstriction (cool, clammy, decreased capillary refill)
- Altered level of consciousness and/or shortness of breath
- Transient responder patients are to be considered as unstable patients.

Associated intra-abdominal injuries (**peritonitis**) are indications for surgery

Splenectomy vs Salvage

The small future risk of overwhelming postsplenectomy sepsis needs to be balanced against the more significant risk of recurrent hemorrhage

Splenectomy is the safest option, given that most patients who require damage-control surgery are on the brink of physiological collapse; are hypothermic, acidotic, coagulopathic; and will likely only poorly tolerate recurrent hemorrhage

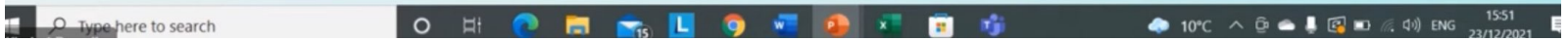
The shift toward nonoperative management with angiographic embolization has decreased the number of patients who would be ideal candidates for operative splenic salvage techniques

Splenorrhaphy

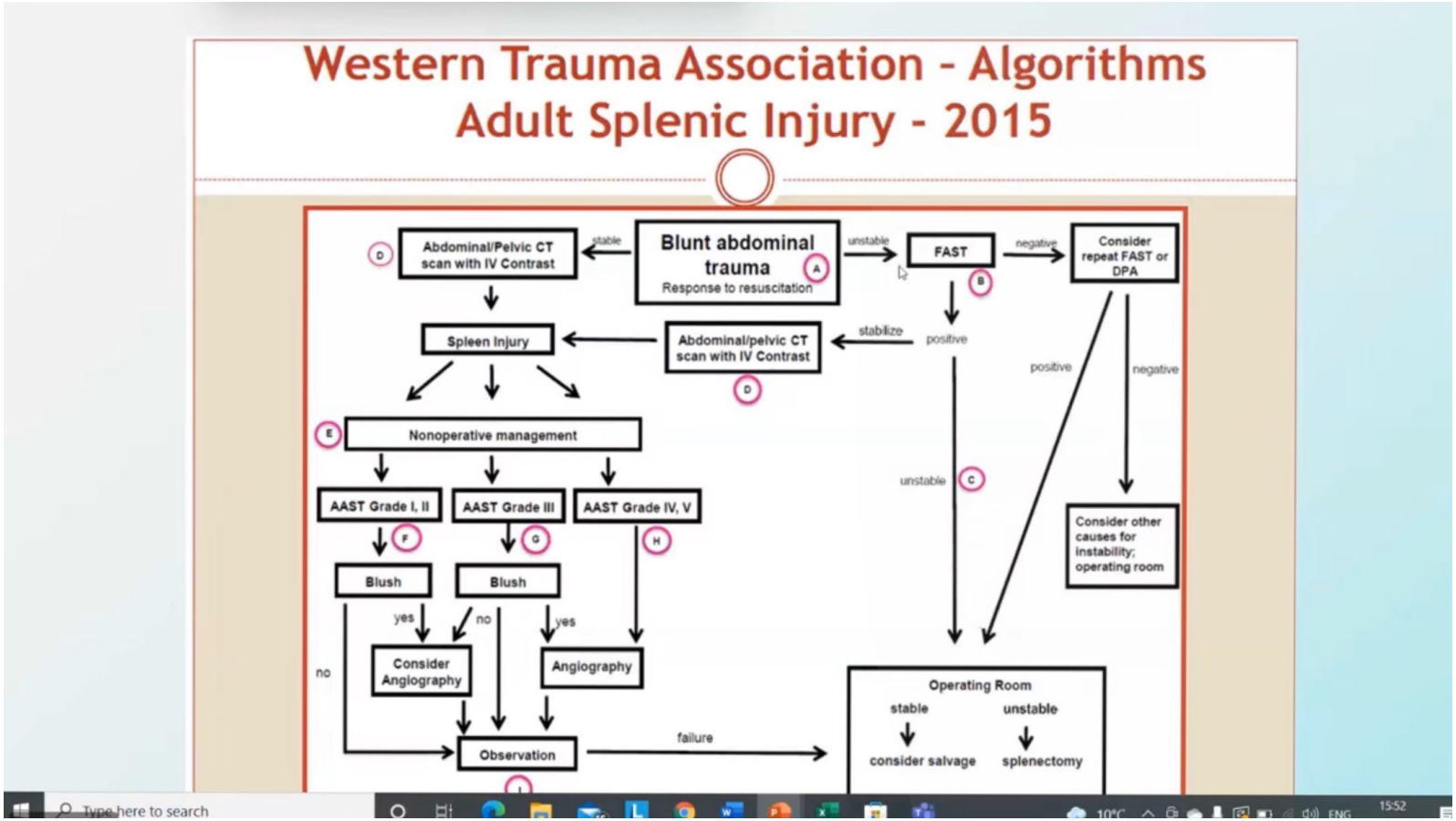
- Splenorrhaphy refers to the suture repair of the spleen with or without splenic wrapping.
- Hemostasis can be achieved with topical hemostatic agents, electrocautery, or argon beam coagulation

Partial splenectomy

Partial splenectomy is a form of splenic salvage and refers to the removal of a portion of the spleen based upon its segmental blood supply



Western Trauma Association - Algorithms
Adult Splenic Injury - 2015



Surgical Outcomes And Complications

- The mortality rate for patients undergoing surgery for **isolated** splenic injury is dependent on the grade of injury, as well as the presence or absence of shock.
- Mortality can be as high as 22 percent for grade V injury
- **Postoperative bleeding**
- **Perioperative infection**
  - Pulmonary complications are the most common postoperative infection
  - Intra-abdominal abscess
- **Gastric perforation** Uncommon but can result from necrosis of the gastric wall
- **Pancreatic fistula**

Vascular thrombosis

- Portal, mesenteric, and splenic veins appear to be affected more often. DVT and PE are still a risk

Thrombocytosis

Usually peaking between 7 and 20 days postoperatively, and then falling to normal levels over weeks to months, but sometimes over years

Splenosis

- Iatrogenic rupture of the spleen during splenectomy can cause subsequent implantation of splenic tissue within the peritoneal cavity, also referred to as splenosis
- This generally does not require any intervention, but it could cause abdominal pain, partial return of splenic function, or other complications

Risk for malignancy

Postsplenectomy sepsis Overwhelming post-splenectomy infections (**OPSI**)

- Fever in a patient with impaired splenic function is a warning sign for possible sepsis and should be treated as a medical emergency
- Postsplenectomy sepsis is a fulminant and rapidly fatal illness due to encapsulated pathogens
- The incidence of postsplenectomy sepsis associated with splenic injury appears to be lower than that for splenectomy performed for other indications.

Immunizations

- Immunisation against encapsulated organisms.
- Following splenorrhaphy or partial splenectomy, the need to immunize is unclear

Long Life Prophylactic Antibiotics

Recommendations for prophylactic antibiotics vary

- A common recommendation for children <5 years of age is for antibiotic prophylaxis for at least two years following splenectomy
- For children and adults with concurrent immunocompromising conditions, daily antibiotics until at least age 18 or for life.
- For children or adults with history of sepsis or other severe infections caused by encapsulated organisms. lifelong prophylaxis.
- For adults, at least one year following splenectomy

The disadvantages of long-term antibiotic use are not insignificant

- These include the potential for hypersensitivity reactions, alteration of the microbiome, the emergence of drug-resistant pathogens, difficulty with adherence and incomplete protection

Clinical Scenario

- 65 yr old male pt, RTA
- On admission GCS 14/15
- B/P 85/50 HR 130
- After Fluids resuscitation B/P120/70 HR 88
- Examination: left upper quadrant tenderness without peritoneal signs.
- Underwent CT scan..