ABDOMINAL AORTIC ANEURYSM

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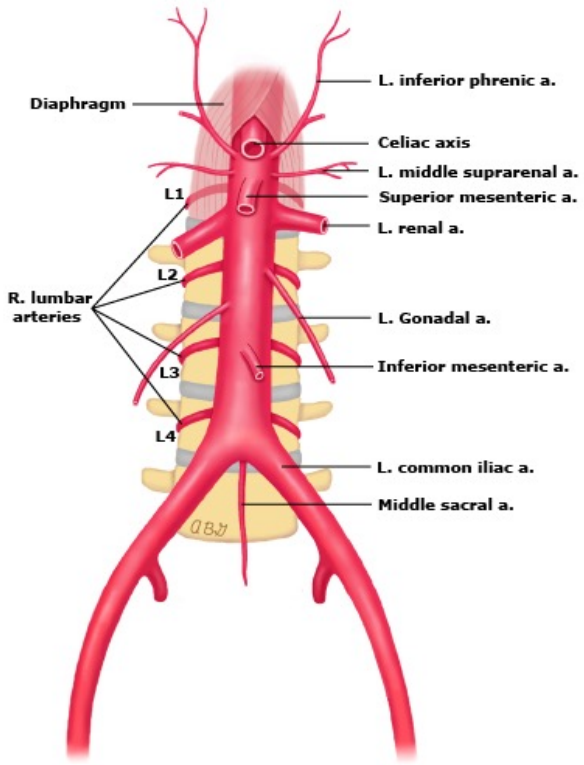
OVERVIEW

- Identify and define AAAs (abdominal aortic aneurysms) based on size and location
- Pathophysiology and risk factors
- Clinical presentation
- Imaging
- Medical management
- Surgical management
- Peri-operative care of patients with AAAs in the ICU setting

Normal abdominal aorta



The abdominal aorta is a retroperitoneal structure that begins at the hiatus of the diaphragm and extends to its bifurcation into the right and left common iliac arteries at the level of the fourth lumbar vertebra.

The branches of the abdominal aorta include (superior to inferior) the left and right inferior phrenic arteries, the celiac axis, left and right middle suprarenal arteries, superior mesenteric artery, left and right renal arteries, left and right gonadal arteries, inferior mesenteric artery, left and right common iliac artery, and middle sacral artery. The paired lumbar arteries (L1-L4) branch from the aorta at mid vertebral body.

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Dalman R. L. MD, & Mell M. MD. (2018). Overview of abdominal aortic aneurysm. Collins (Ed.) *UpToDate*. Retrieved November 1, 2019, from www.uptodate.com.

DEFINITIONS/CLASSIFICATIONS

- Abdominal aortic aneurysm (AAA) definition: abdominal aortic diameter > 3.0cm
- Main risk of aortic aneurysm: **rupture**
- Size Classification:
  - < 5.5 cm in men and < 5.0 cm in women – low risk of rupture → observe
  - > 5.5 cm in men and > 5.0 cm in women – risk of rupture significant → need repair
  - Average rate of expansion 0.3 – 0.4cm/year
    - Aneurysm growth >0.5cm in 6 months → fast growth → consider repair at smaller size

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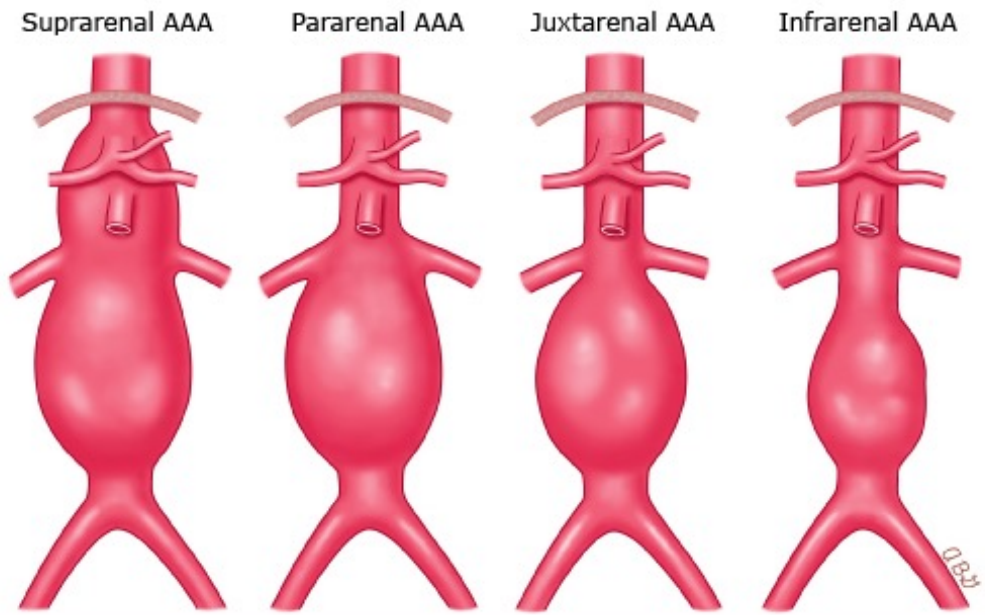
LOCATION CLASSIFICATION

- Infrarenal: there is a non-aneurysmal segment below the renal arteries before the aneurysm begins
  - Most common
- Juxtarenal: aneurysm starts just below the renal arteries
- Pararenal: renal arteries take off from the aneurysmal aorta (SMA not involved)
- Suprarenal: involves 1+ visceral arteries but does not extend into the chest

Classification of abdominal aortic aneurysm



Abdominal aortic aneurysms (AAAs) are commonly described based on the relation to the renal arteries.

- Suprarenal AAA: The aneurysm involves the origins of one or more visceral arteries but does not extend into the chest.
- Pararenal AAA: The renal arteries arise from the aneurysmal aorta but the aorta at the level of the superior mesenteric artery is not aneurysmal.
- Juxtarenal AAA: The aneurysm originates just beyond the origins of the renal arteries. There is no segment of nonaneurysmal aorta distal to the renal arteries, but the aorta at the level of the renal arteries is not aneurysmal.
- Infrarenal AAA: The aneurysm originates distal to the renal arteries. There is a segment of nonaneurysmal aorta that extends distal to the origins of the renal arteries.

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PATHOPHYSIOLOGY & RISK FACTORS

PATHOPHYSIOLOGY

- Normal remodeling requires balance between proteases (that break down tissue) and their inhibitors

- AAA: imbalance between proteases and inhibitors
  - Increase in inflammatory cytokines: IL-1B and TNF-α
  - Cytokines → increase matrix metalloproteinases (MMPs)
  - MMPs take over and destruct collagen and elastin in the ECM → thinning of aortic wall → dilation and aneurysm

RISK FACTORS for AAA
Smoking
Family history of AAA
Male
HTN
Older age
Caucasian
HLD

- There is a decreased risk of AAA in DM
  - Diabetics have a thicker aorta → decreases wall stress

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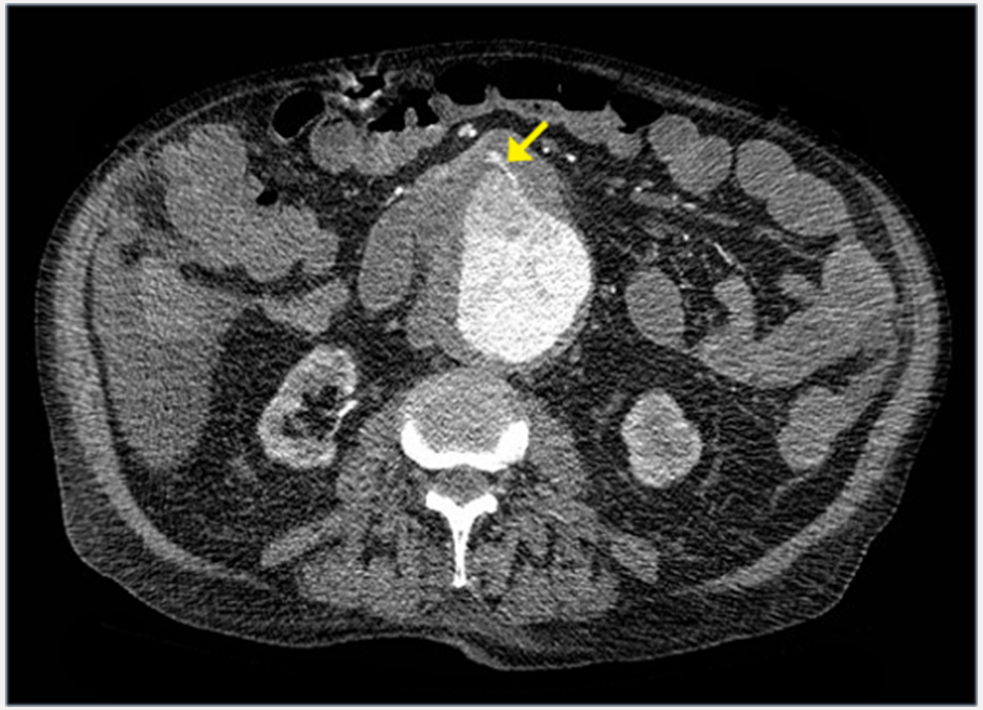
CLINICAL PRESENTATIONS

- Asymptomatic
  - MOST COMMON
  - Found incidentally on imaging for another cause or preventative maintenance surveillance for smoking history
- Symptomatic
  - Fast expansion → pain
  - Compression/Erosion into surrounding structures – mostly in inflammatory
    - Ureteral compression → hydronephrosis and flank pain
    - Bowel (rare)
      - Aortoenteric fistula → hematemesis or hematochezia
      - Small bowel obstruction
- Rupture
  - Triad of severe pain, hypotension and pulsatile abdominal mass
  - Diagnosis missed initially up to 30% of the time



Aortoenteric fistula with extravasation of contrast from aorta into bowel (yellow arrow)

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DIAGNOSIS AND SURVEILLANCE

- Duplex ultrasound is preferred outpatient screening and surveillance method

Society for Vascular Surgery (SVS) Guidelines for AAA Surveillance
(Level of Evidence/Quality of Evidence Rating)

Ultrasonographic examination as the preferred surveillance method (1/A)
One-time screening for patients aged 65 to 75 years with a history of tobacco use (1/A)
Imaging every 3 years for AAAs of 3.0 to 3.9 cm (2/C)
Annual imaging for AAAs of 4.0 to 4.9 cm (2/C)
Imaging twice per year for AAAs of 5.0 to 5.4 cm (2/C)

- Once the decision to treat is made, a CT scan is the gold standard for planning

Cooper MA, Upchurch GR. The Society of Vascular Surgery Practice Guidelines on the Care of Patients With Abdominal Aortic Aneurysms. *JAMA Surg.* 2019;154(6):553–554

MEDICAL MANAGEMENT

- Appropriate for small aneurysms and non-operative candidates
- There is a lack of RCTs and formal guidelines looking at risk reduction for AAAs
- Smoking cessation
  - Reduces all-cause mortality
  - Reduction in aneurysm-related mortality
- Reduction of cardiovascular risk factors
  - Statin therapy recommended in all patients with AAA
    - No RCT data
    - A small study showed Simvastatin reduced MMP levels in aortic wall by 40%
  - Antiplatelet therapy with low-dose aspirin recommended to reduce overall cardiovascular risk

Golledge, J. Powell, J.T. (2007). Medical Management of Abdominal Aortic Aneurysm. European Journal of Vascular Surgery. 34(3). 267-273. doi:10.1016

MEDICAL MANAGEMENT (CONT.)

- Hypertension treatment
  - ACE inhibitors associated with decreased AAA rupture in a retrospective analysis
  - Beta blockade studies inconclusive due to lack of adherence to therapy
  - Calcium channel blockers showed no significant benefit

- Future potential therapies
  - Metformin
    - There are ongoing studies of Metformin in non-diabetic patients for potential reduction in AAA expansion
    - Metformin may reduce AAAs due to protective role in the inflammatory pathway
  - Antibiotics
    - Tetracyclines and Macrolides decrease MMPs
    - Small RCTs have shown some potential with these drugs to reduce growth, but larger studies needed

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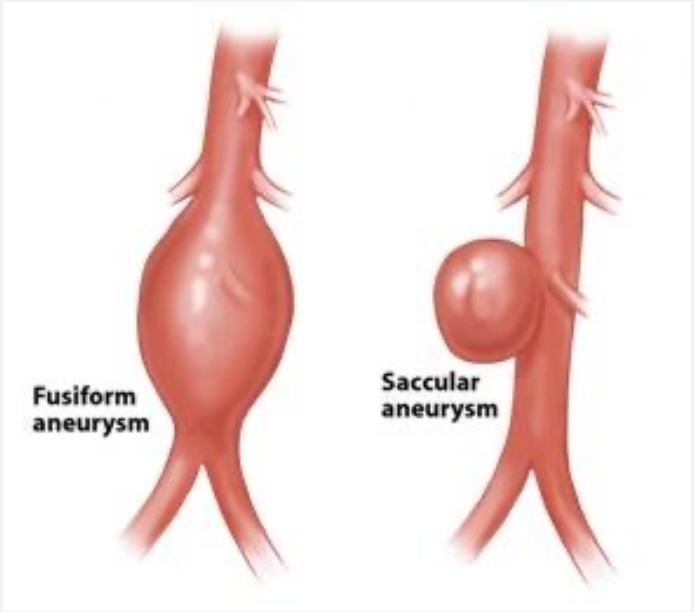
SURGICAL MANAGEMENT – WHEN TO REPAIR



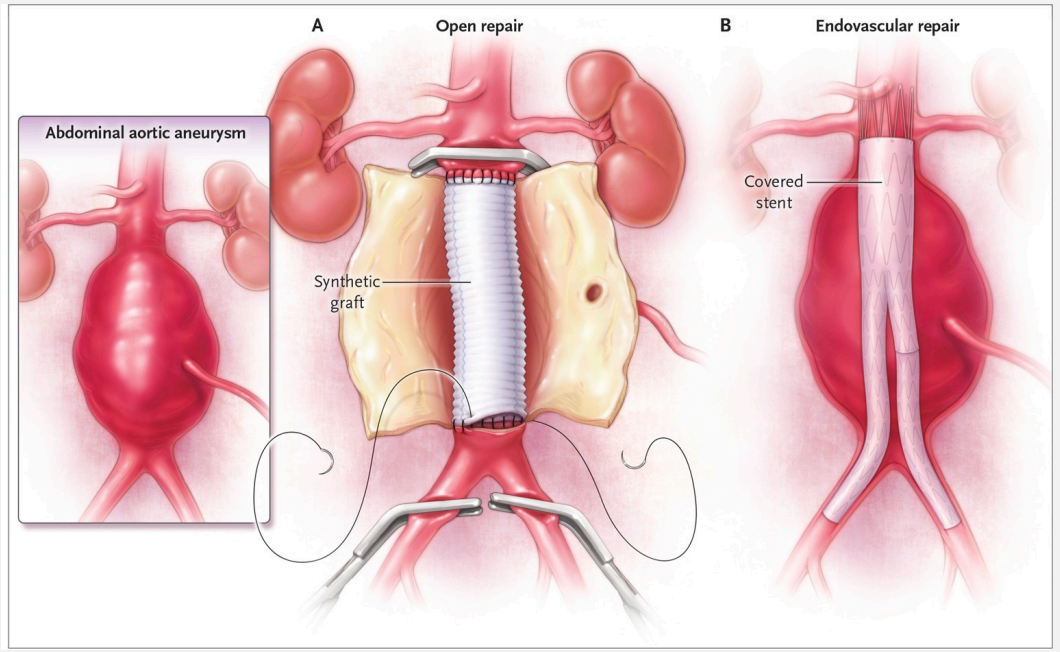
Society for Vascular Surgery (SVS) Guidelines for AAA Treatment
(Level of Evidence/Quality of Evidence Rating)

Decision to treat with elective repairs

- Fusiform aneurysms of 5.5 cm or larger (1/A)
- All saccular aneurysms (2/C)
- Aneurysms of 5 cm or larger in women (2/B)

Operative approach

- Preserve at least 1 hypogastric artery (1/A)
- Endovascular aneurysm repair recommended for ruptured AAA (1/C)



- Treatment
  - Asymptomatic aneurysms should be treated with the approach above
    - Treatment can be endovascular or open (see following slides)
    - Saccular aneurysms higher risk for rupture → treated at lower sizes
  - All symptomatic aneurysms should be treated urgently

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SURGICAL MANAGEMENT – OPEN VERSUS ENDOVASCULAR REPAIR – TRIAL DATA

- OVERALL CONCLUSIONS
  - EVAR (endovascular aortic repair) associated with lower immediate post-operative morbidity and mortality
  - OSR (open surgical repair) associated with decreased long-term morbidity and mortality
  - Open repair preferred for good surgical candidates

- 2013 meta-analysis of 25,078 EVAR patients and 27,142 OSR patients
  - Lower 30-day mortality with EVAR
  - Same 2-year all-cause mortality (EVAR, 3586 of 25 078 [14.3%]; OSR, 4071 of 27 142 [15.2%]; odds ratio, 0.87 [95% CI, 0.72-1.06]; *P* = .17)
  - ***More EVAR patients required re-intervention and had late aneurysm rupture***
- DREAM trial (Dutch trial comparing open and endovascular repair)
  - Similar 12-year survival rate (OSR, 41.7%; EVAR, 38.4%; 3.3% difference [95% CI, −7.1% to 13.7%]; *P* = .48)
  - Higher *freedom from* re-intervention for OSR (OSR, 86.4%; EVAR, 65.1%; 21.3% difference [95% CI, 11.2%-31.4%]; *P* = .001)
- EVAR 1 trial
  - After 8 years, EVAR associated with higher all-cause mortality (adjusted hazard ratio, 1.25 [95% CI, 1.00-1.56])
  - After 8 years, EVAR associated with aneurysm-associated mortality (adjusted hazard ratio, 5.82 [95% CI, 1.64-20.65])

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Patel R, Sweeting MJ, Powell JT, Greenhalgh RM; EVAR trial investigators. Endovascular versus open repair of abdominal aortic aneurysm in 15-years' follow-up of the UK endovascular aneurysm repair trial 1 (EVAR trial 1): a randomised controlled trial. *Lancet*. 2016;388(10058):2366-2374.

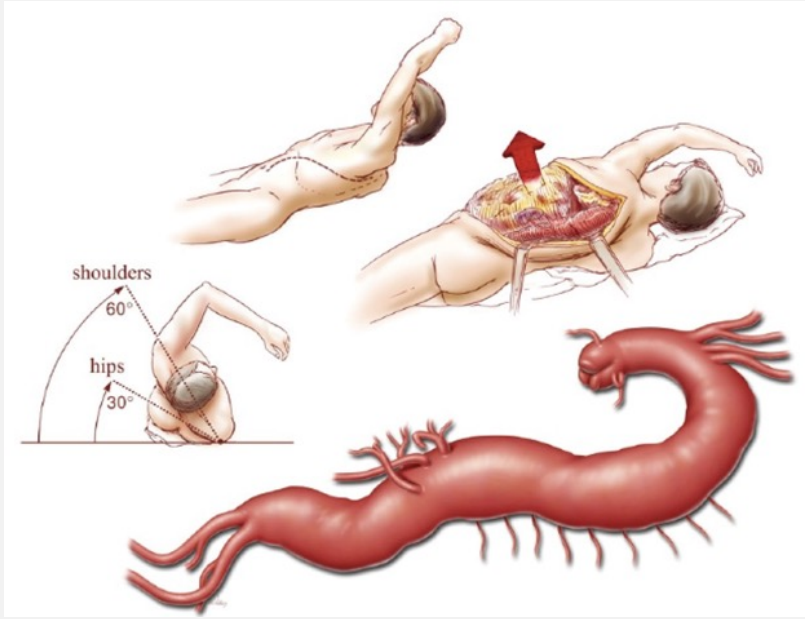
OPEN REPAIR

- Can use transperitoneal or retroperitoneal approach
- Approach depends on exposure needed for repair and previous surgeries

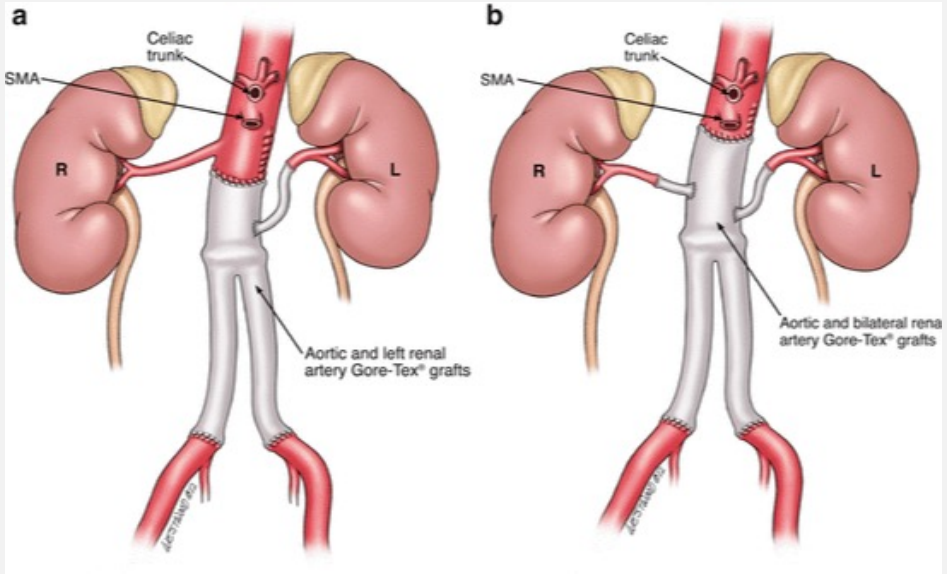
- Transperitoneal
  - Better view of right iliac and femorals
  - Higher rates of ileus
  - Associated with less chronic pain

- Retroperitoneal approach
  - Better for more proximal aneurysms
  - Lower risk of ileus and pneumonia

Retroperitoneal positioning and incision



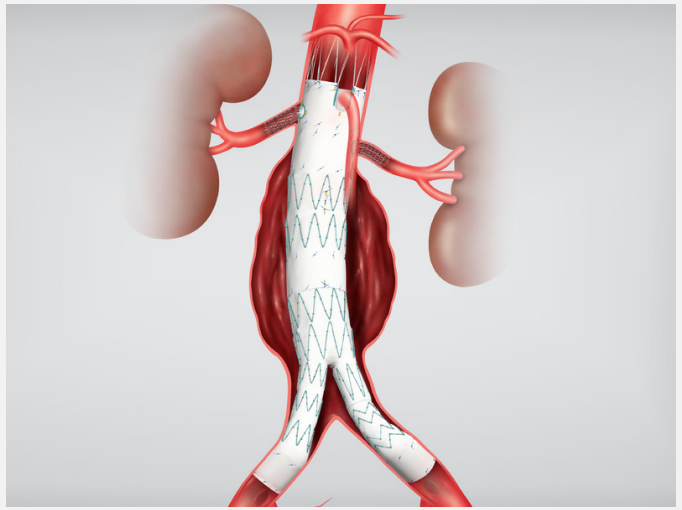
Open repair of juxtarenal aneurysm with renal bypass



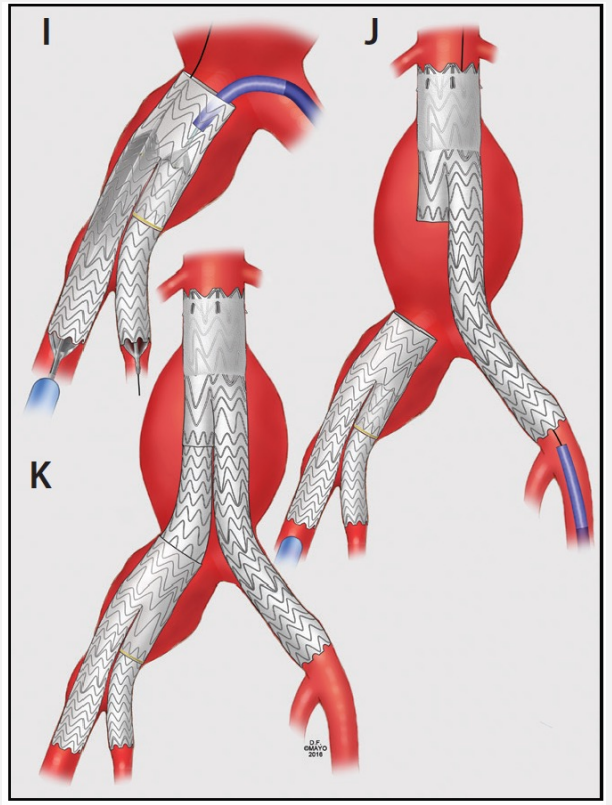
Eidt J. F. MD. (2019). Open surgical repair of abdominal aortic aneurysm. Collins (Ed.) *UpToDate*. Retrieved November 1, 2019, from www.uptodate.com.

ENDOVASCULAR REPAIR

- EVAR depends on seal in normal, non-aneurysmal, aorta and iliacs
- Need sufficient infrarenal neck **or** placement of stents into visceral arteries to be able to bring graft proximally into normal aorta
- Can coil hypogastric or perform a bifurcated stent graft in iliacs if needed to bring graft into normal external iliac if common iliac aneurysmal
- Need sufficient iliac and femoral diameters to deliver graft
  - Iliac conduits (cutdown on iliac arteries) can be used if small iliacs to allow graft to be delivered if more distal arteries too small



Fenestrated endograft (aka graft with holes created for placement of stents through them) with stents in the renal arteries to bring graft seal into normal aorta proximally



Bifurcated iliac graft and infrarenal EVAR for aneurysmal aorta and right iliac

POST-OPERATIVE ICU CARE – OPEN REPAIR

Infrarenal

- Mostly midline incision
- Have bowel manipulation = ileus risk
- Post-op
  - Need IVF resuscitation → trend lactates
  - RISK FOR BLEEDING → trend CBCs
  - Maintain intubated POD 0
  - NPO with NGT
  - Continue a line and foley
  - BP goal: normotensive
    - Use short-acting drips in immediate perioperative period

Thoracoabdominal (Juxtarenal/Perirenal/Suprarenal)

- RP incision
- Bypass to one or both kidneys +/- bowel
  - Can have renal failure
  - Can have bowel infarction
- Post-op
  - Large volume IVF resuscitation → trend lactates
  - RISK FOR BLEEDING → trend CBCs
  - Maintain intubated POD 0
  - NPO with NGT
  - Continue a line and foley
  - BP goal: normotensive
    - Use short-acting drips in immediate perioperative period

ICU CARE - OPEN ANEURYSMS - ANEURYSM SPECIFIC COMPLICATION MANAGEMENT

- AKI
  - High risk with any open aortic surgery – increased with suprarenal clamp
  - Risk higher with any pre-operative renal insufficiency
  - Need to follow renal function, prevent hypotension and maintain hydration
- Lower extremity ischemia
  - Aortic mural thrombus can trash down into the lower extremity – normally this is noted in the OR and fixed at that time
  - Perform serial lower neurovascular exams and notify vascular surgery team with any changes
- Bowel ischemia
  - Can happen due to embolization from clamping, if there is a bypass that goes down, or if IMA is sacrificed and SMA collaterals not sufficient
  - Be concerned if there is abdominal pain that is worsening
  - First step is to obtain a sigmoidoscopy
    - If partial-thickness ischemia → bowel rest and broad spectrum antibiotics
    - If full thickness necrosis → need OR for resection

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POST-OPERATIVE ICU CARE – ENDOVASCULAR REPAIR

Infrarenal

- If percutaneous: flat x 6 hours to allow repairs to heal
- Post-op
  - Minimum IVF
  - Regular diet
  - BP goal: normotensive
  - Foley out early POD 1
- Home POD 1 – 2

FEVAR: Fenestrated Endovascular Aortic Aneurysm Repair

- Patient population – those we can't do open
  - Frail
  - Debilitated
  - Poor lung function
- Stents in celiac, SMA, bilateral renals
  - Risk for bowel and renal ischemia
  - VERY IMPORTANT TO FOLLOW POST-OP CMP, LACTATE
- Post-op – like an EVAR
  - Minimize IVF resuscitation
  - Regular diet
  - Home POD 1 - 2

REFERENCES

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