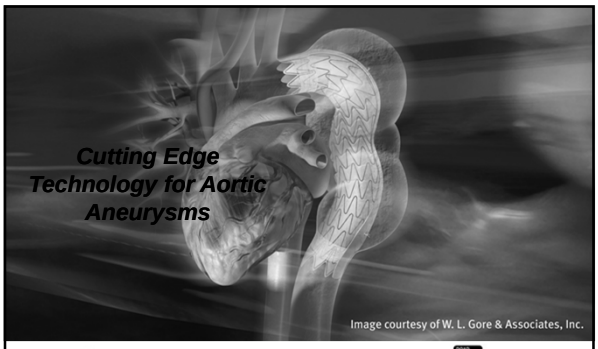

UnityPoint Health Methodist, Peoria, IL

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Aortic Aneurysms
How Big is the Problem?

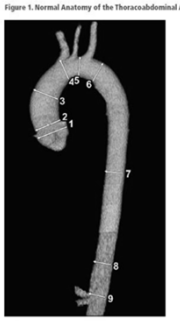
- 1 - 5 % of general population affected
  - Incidence is increasing
- AAA: 100,000 – 250,000 new cases each year in the U.S.
- TAA: approximately 15, 000 new cases each year
- 43,000 – 47,000 deaths per year (CDC)
  - Twice as many deaths from thoracic aortic dissection and rupture than abdominal

Aortic Aneurysms
How Big is the Problem?

- 10th – 18th leading cause of death in the USA
- 2/3 of patients who suffer a ruptured aneurysm will die before even reaching the hospital.
- 90% mortality with ruptured AAA

Source: Society of Thoracic Surgeons

Normal Size of Aorta



Size in CM	
Root	3.5–3.91
Ascending	2.86
Mid Descending	2.39–2.64
Diaphragmatic	2.43-2.69

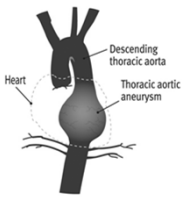
Source: J Vasc Surg 1991;13:452-8 and 2010 Guidelines TAD.

Aortic Aneurysm (AA)

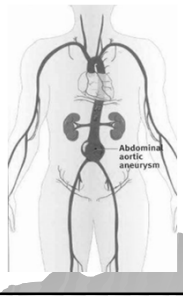
- Abnormal dilation of the aortic wall that alters the vessel shape and blood flow
  - 50% increase in the diameter of a vessel in comparison of it's expected normal
- With gradual enlargement, the aorta becomes increasingly weakened, leading to possible dissection and rupture.

Aortic Aneurysm (AA)

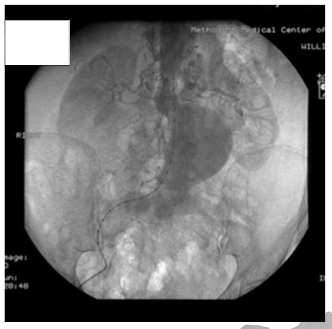
Thoracic
TAA



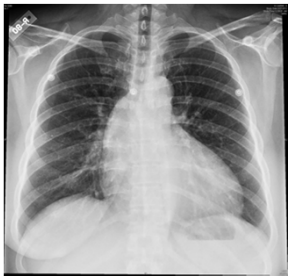
Abdominal
AAA

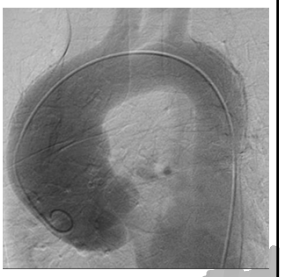


Abdominal Aneursym



Thoracic Type A Aneurysm





Risk Factors

- Hypertension
- Increasing Age
- Smoking
- Cocaine or other stimulant use
- Weight lifting or other valsalva maneuver
- Trauma
- Deceleration or torsional injury
- Family history
- Marfan's syndrome
- Loeys-Dietz Syndrome
- Turner Syndrome
- Pheochromocytoma
- Coarctation of the aorta
- Bicuspid valve

Smoking

- Current smokers are seven times more likely to develop AAA than non-smokers.
- Former smokers are three times more likely.
- Strongest modifiable risk factor for development of aneurym.

Risk

- Aortic aneurysm disease is rare under the age of 50.
- Mean age of patient undergoing repair is 70.

Precipitating Events of onset of acute aortic dissection

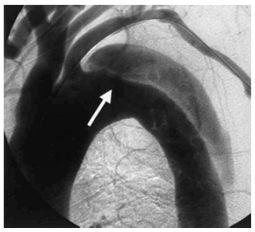
- Extreme exertion
  - Weight lifters (Yale)
  - Extreme elevation in BP
- Episode of severe emotional upset

Aortic Aneurysm Rupture

- A tear in the vessel wall near or at the location of the ballooning of the weakened area of the aorta allowing blood to hemorrhage into the chest or peritoneal cavity
- Rupture carries a 90% mortality

Dissection

- Tear in the intimal layer of the aortic wall
- Blood passes into the aortic media through the tear separating the intima from the surround media and/or adventitia, creating a false channel within the aortic wall



Dissection

- Acute Dissection
  - Diagnosed within 14 days of the onset of symptoms
  - The risk of death is greatest during this acute period
- Chronic Dissection
  - Diagnosis after two weeks of the onset of symptoms

A Silent Disease

- 40% of individuals are asymptomatic at the time of diagnosis
  - Often discovered on a routine CXR or abdominal sonogram
- Only 5% of patients are symptomatic before an acute aortic event.
  - The other 95%, the first symptom is often death

AA Dissection Symptoms "The Great Imitator"

- S/S depend where the dissection occurs and what area is not getting oxygen
- Confused with:
  - Kidney stones
  - Gallstones
  - Paralysis -- think neuro diagnosis
  - Myocardial infarction

AA Symptoms

- Abrupt onset of excruciating pain in chest, back, or abdomen
  - Ascending Dissection
    - Retrosternal pain that is not exertional in nature
  - Descending Dissection
    - Interscapsular chest pain
    - Severe flank pain
    - Epigastric pain
- Ripping, tearing, stabbing and or sharp quality of pain

High Risk Examination Features

- Pulse deficit
- Systolic BP limb differential >20mm Hg
- Focal neurologic deficit
- Murmur of aortic regurgitation
- Hypotension or shock state

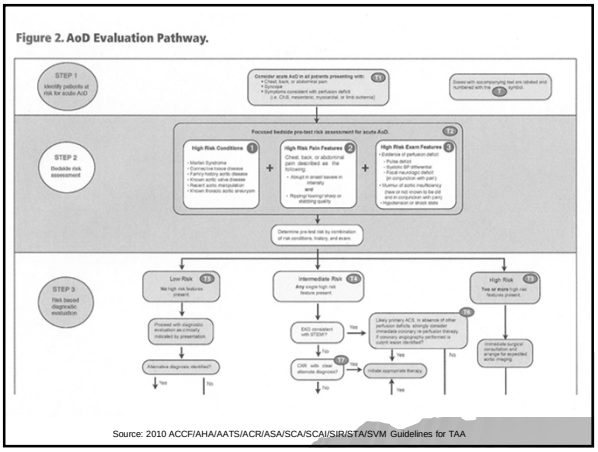
Thoracic Dissection Symptoms

- Severe tearing pain of sudden onset
- Pain has a tendency to migrate from its point of origin to other locations following the path of dissection

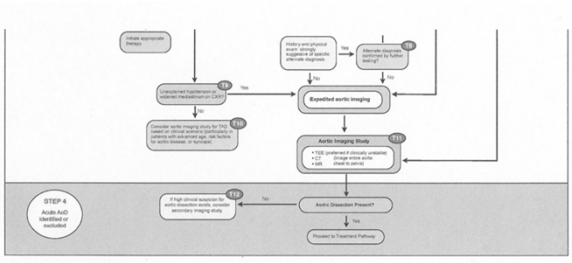
2010 ACCF/AHA/AATS/ACR/ASA/ SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients with Thoracic Aortic Disease

Developed in partnership with the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine.

Endorsed by the North American Society for Cardiovascular Imaging.



Source: 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STA/SVM Guidelines for TAA



ACS indicates acute coronary syndrome; AoD, aortic dissection; BP, blood pressure; CNS, central nervous system; CT, computed tomographic imaging; CXR, chest x-ray; EKG, electrocardiogram; MR, magnetic resonance imaging; STEMI, ST-elevated myocardial infarction; TAD; thoracic aortic disease; and TEE, transesophageal echocardiogram.

Source: 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STA/SVM Guidelines for TAA

You suspect a dissecting/rupturing aneurysm….

Now What??

Rapid Triage & Treatments

- Aortic Center Aortic Pathway
  Methodist Hospital Houston. TX

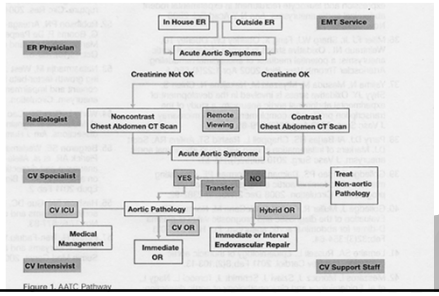
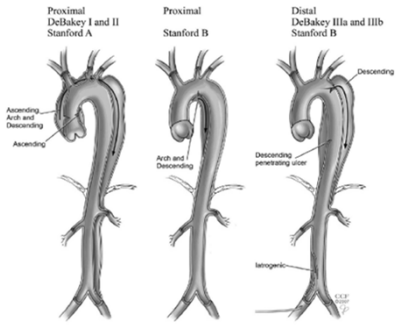


Figure 1 AATC Pathway

Diagnostics

- 12 Lead EKG to r/o STEMI
- Chest x-ray – not very helpful as no abnormalities noted
- CT scan

Aortic Dissection Classification: DeBakey and Stanford Classifications



Note: Figure 20 in full-text version of TAD Guidelines. Reprinted with permission from The Cleveland Clinic Foundation.

Dissections

- 62% are Type A
- Type B are typically older than Type A
- Type A
  - Immediate operation room intervention
- Type B
  - Medical management

Acute AoD Management Pathway

STEP 2: Initial management of aortic wall stress

Intravenous rate and pressure control

Rate/Pressure Control (1)

Intravenous beta blockade or Labetalol (If contraindication to beta blockade substitute diltiazem or verapamil)

Titrate to heart rate <60

+

Pain Control (2)

Intravenous opiates

Titrate to pain control

No ← Hypotension or shock state?

Yes → Anatomic based management

Systolic BP >120mm HG?

Secondary pressure control

BP Control (3)

Intravenous vasodilator

Titrate to BP <120mm HG (Goal is lowest possible BP that maintains adequate end organ perfusion)

Acute AoD Management Pathway

STEP 2: Initial management of aortic wall stress

Anatomic based management

Type A dissection

1. Urgent surgical consultation
   +
   Arrange for expedited operative management
2. Intravenous fluid bolus
   •Titrate to MAP of 70mm HG or Euvolemia (If still hypotensive begin intravenous vasopressor agents)
3. Review imaging study for:
   • Pericardial tamponade
   • Contained rupture
   • Severe aortic insufficiency

Type B dissection

1. Intravenous fluid bolus
   •Titrate to MAP of 70mm HG or Euvolemia (If still hypotensive begin intravenous vasopressor agents)
2. Evaluate etiology of hypotension
   • Review imaging study for evidence of contained rupture
   • Consider TTE to evaluate cardiac function
3. Urgent surgical consultation

Indications for AA repair

Thoracic

- Symptomatic
- Diameter 5.5 - 6 cm
- Diameter 4.4 - 5 cm associated with genetic disorder(Marfan's syndrome)
- Symptoms suggesting expansion or compression of surrounding structures

Indications for AA repair

Abdominal

- Diameter $\geq$ 5 cm
- Diameter $\leq$ 4 cm needs regular follow up
- Diameter 4 – 5 cm, management is controversial

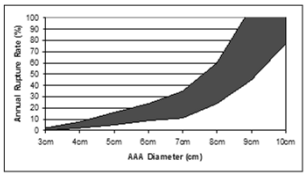
Indications for AA repair

Both: TAA & AAA

- Rapidly expanding aneurysms
  - growth rate > 0.5 cm/year
- Symptomatic aneurysm regardless of size

Size --- It really does matter!

Annual Incidence of Rupture



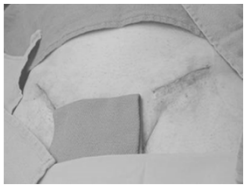
- At 6 cm – aorta becomes a rigid tube
- It cannot stretch in systole
- Results in high wall stress
- 34% risk of rupture
  - TAA at 6 cm
  - AAA at 7 cm

Repair of AA

Traditional:

Open surgical repair

Evolving Trend:



Endoluminal grafting (ELG)

Surgical Repair for AAA

- **> 50 years since first repair**
- **Average mortality 4%**
- **Significant short & long-term morbidity**
- **Causes of aneurysm related death well defined**

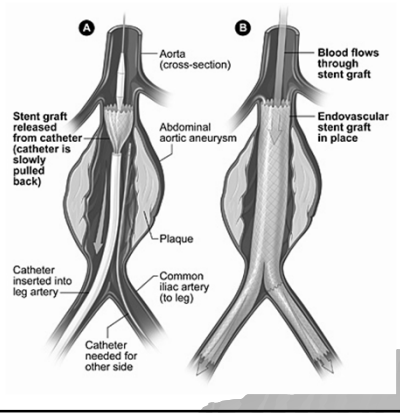
Functional Outcome after Open Repair of Abdominal Aortic Aneurysm

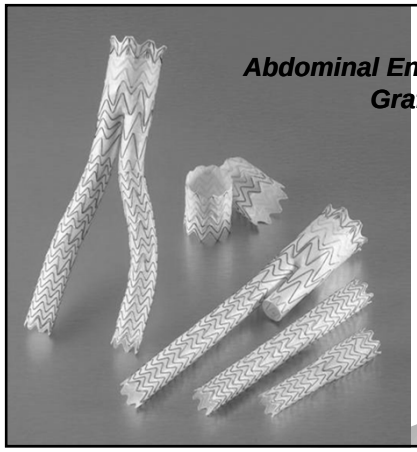
Operative Mortality	**4% (154 pts.)**
Mean LOS	**10.7 days**
ICU LOS	**4.6 days**
Ambulatory Post-op	**64% (25 mos.)**
Decreased Functionality	**33%**
Time to Recovery	**3.9 mos.**
Unrecovered	**33%**
Again?	**18% - No**

Williamson, et al – Portland, Oregon
J Vasc Surg 2001;33:913-20

Evolving Trend: Abdominal Endovascular Graft

Synthetic, two piece bifurcated graft, that lines the aorta and extends from below the renal arteries into both the iliac arteries

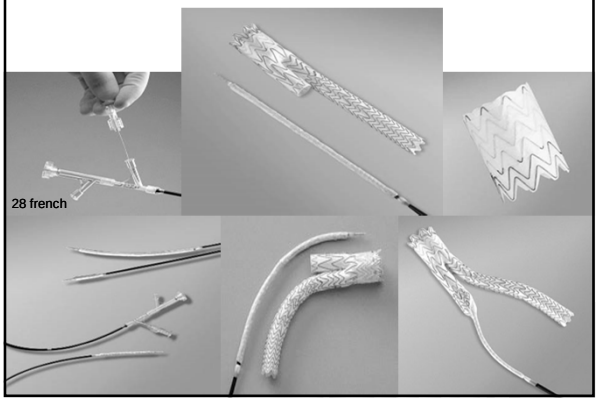




Abdominal Endovascular Graft

- First implanted 1997
- FDA approved November 2002

Gore *Excluder*

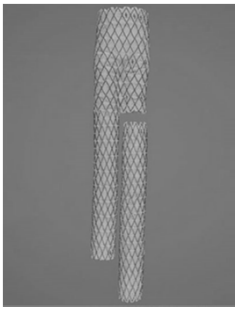


Endologix PowerLink System

GRAFT

- Strong, thin walled ePTFE
- One piece bifurcated stent graft

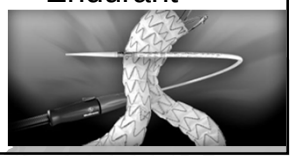
AneurRx



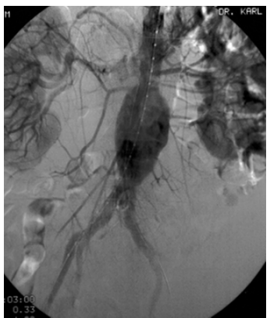
Medtronic

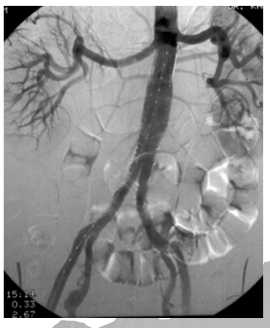
Talent

Endurant



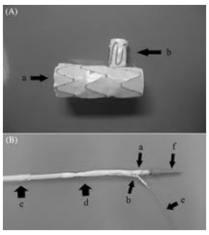
Aneurysm Before & After Endografting





Branched Endografts

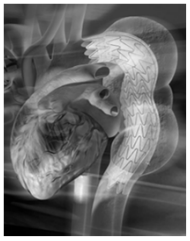
- Pre-attached limbs or cuffs targeted for the aortic branches.
- Cuffs are deployed in the targeted branch

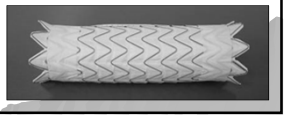


TAG Thoracic Endograft

TEVAR: Thoracic Endovascular Aneurysm Repair

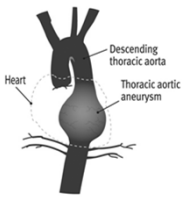
INDICATIONS:
Thoracic Aneurysms
Acute and Chronic Thoracic Dissection





TEVAR

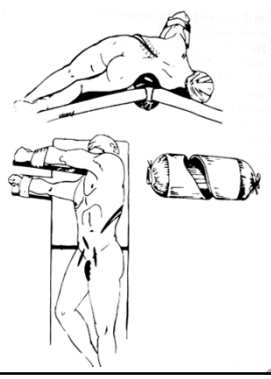
Thoracic
TAA

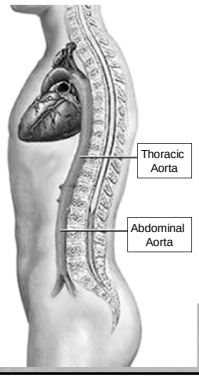


2003
Starting treating TAA with endografts in Peoria

2005 FDA approved

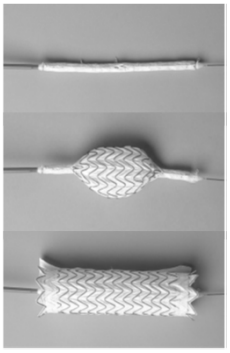
Morbidity of Open Repair

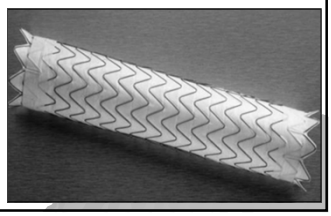




Gore TAG

Deploys from the middle to the end
This prevents windsock
Windsock can move graft 3 – 5 cm





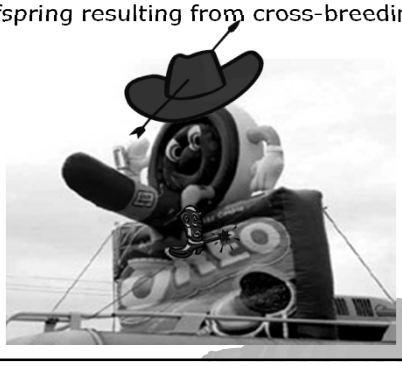
Approved by the FDA on March 23, 2005.

Medtronic Talent Stent Graft

Push pull method to open
Can migrate during cardiac cycle while deploying.
Use Adenosine to stop heart while deploying.
Deploys proximal to distal

Definition of Hybrid

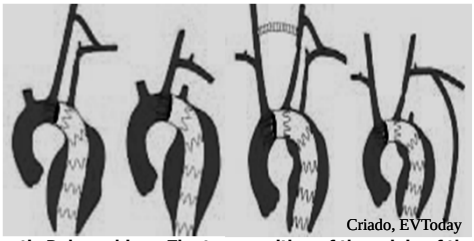
An offspring resulting from cross-breeding



Hybrid Open/Endovascular Aneurysm Repair

- Hybrid approach: combines standard operative approaches and endografts and/or conduit creation/de-branching
- De-branching: the transposition of the origin of critical branch vessels to facilitate a seal zone

Aortic Debranching
Extra-anatomical Bypass



- **Aortic Debranching: The transposition of the origin of the critical branch vessels to facilitate a seal zone.**
- **Aortic Debranching is used to provide blood flow around the arch arteries that become occluded when a TAG is placed in the ascending aorta.**

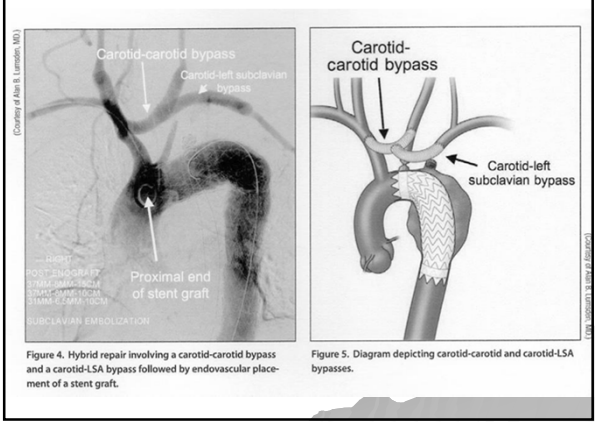
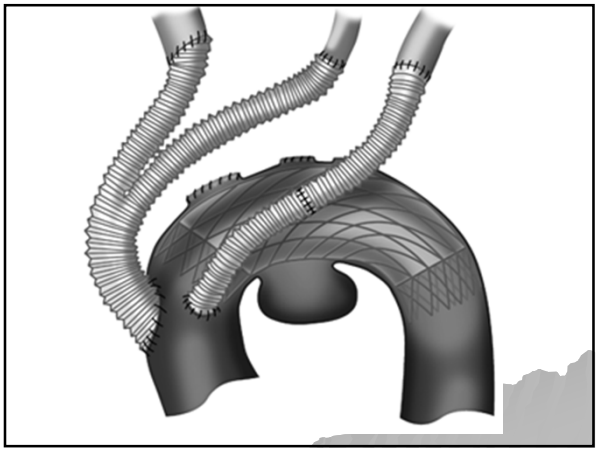


Figure 4. Hybrid repair involving a carotid-carotid bypass and a carotid-LSA bypass followed by endovascular placement of a stent graft.

Figure 5. Diagram depicting carotid-carotid and carotid-LSA bypasses.



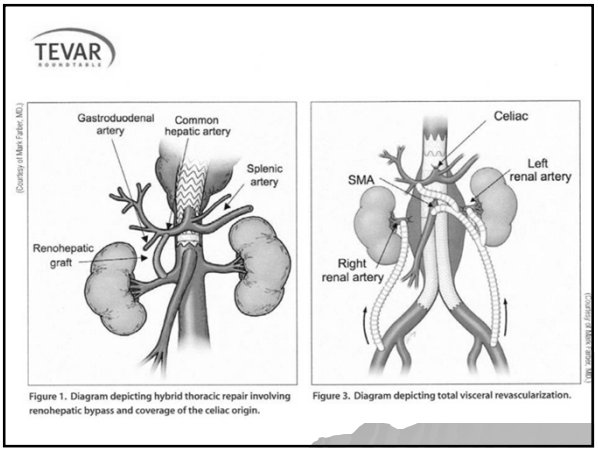


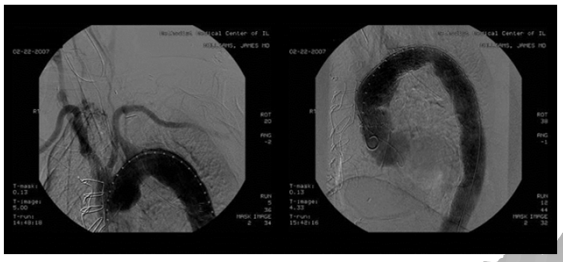
Figure 1. Diagram depicting hybrid thoracic repair involving renohepatic bypass and coverage of the celiac origin.

Figure 3. Diagram depicting total visceral revascularization.

Photos courtesy of
Dr James Bertram Willliams

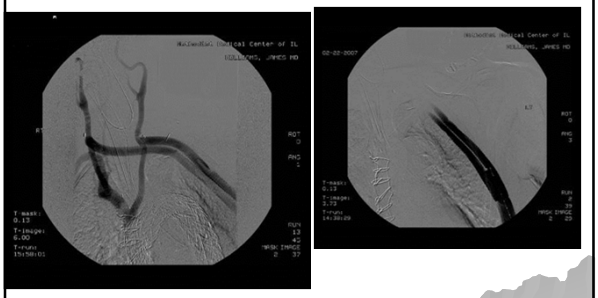
- A board-certified cardiothoracic and vascular surgeon Peoria, IL
- Principal investigator in a number of U.S. clinical device trials for endovascular devices.
- Endovascular Therapies Fellowship Training (ETFT) Program, a six-week visiting fellowship program www.etft.org

TAG inserted covering the subclavian artery.

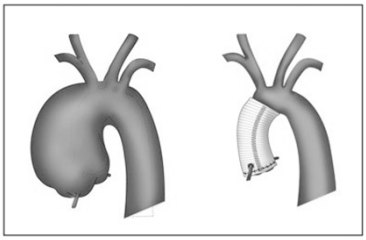


Pre TAG Post TAG

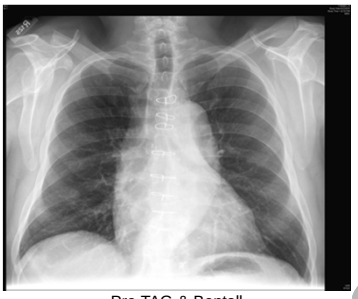
Aorto bi-carotid bypass:
Y graft to the left & right common carotids
and the infrarenal abdominal aorta



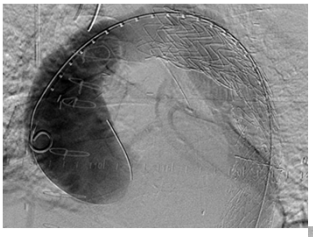
Hybrid:
Bentall's Procedure with TAG



DISEASE REPLACEMENT

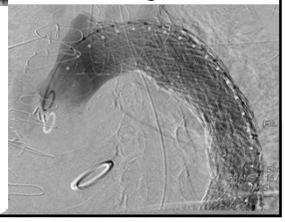


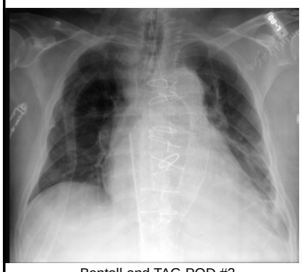
Pre TAG & Bentall



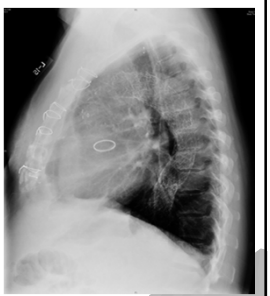
TAG prior to Bentall

Bentall Ring & TAG





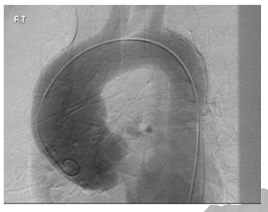
Bentall and TAG POD #2



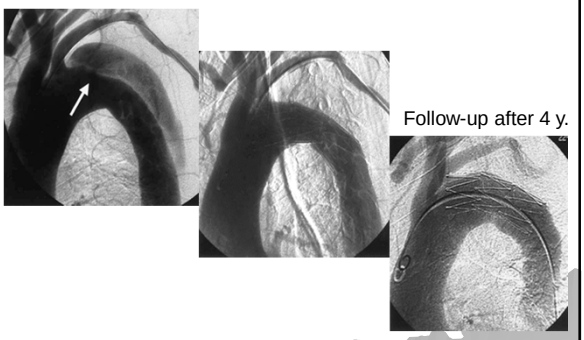
lateral Bentall & TAG

Type A Dissection

- Immediate operating room intervention



Acute Type B dissection



Kato N, et al. J Vasc Surg 2003;38:1130-1

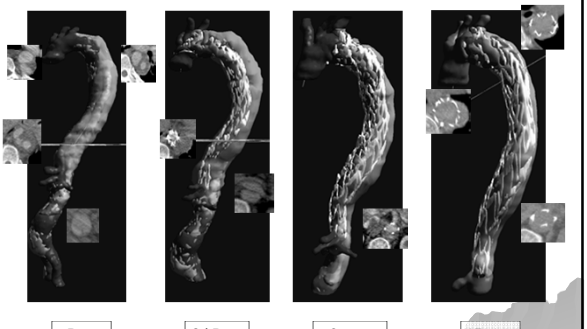
Acute Type B Complicated Dissection

- Goal is to have the true lumen re-expand and the false lumen to resolve
- Need to understand anatomy of the dissection to know what the true lumen vs false lumen is feeding
- Prefer to wait 8 - 9 days to treat as will have less complications
- If repair 3- 5 days after dissection→ significant re – dissection
- If wait longer than 9 days, then the true lumen may not re-expand

Acute, Uncomplicated Type B Dissections

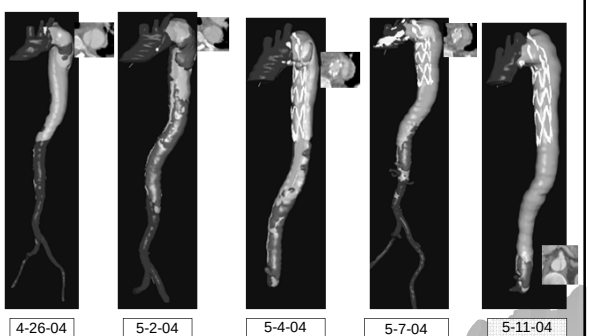
- Medical management is currently the most appropriate treatment
- Acute < 14 days

Acute Type B Dissection

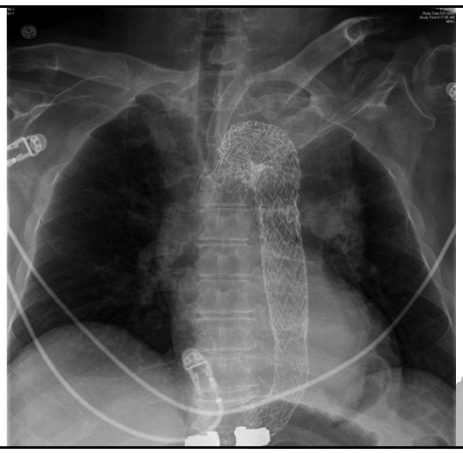


Courtesy Rodney White, MD

Chronic Type B Dissection



Courtesy Rodney White, MD



Nursing Care

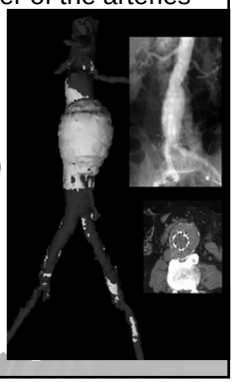
Preoperative Care

- Usually AM admit
- Hydrate with NS at 125 -150 ml/hour
- If Creatinine > 1.6 may give Mucomyst or Bicarbonate infusion (3 amps Bicarb/1000ml D5W at 3 ml/hr x 6 hours --- start 1 hour preop)
- Permit to include possible resection of aortic aneurysm
- Teaching

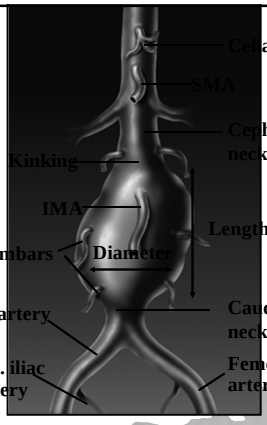
Preop Diagnostics

To measure length & diameter of the arteries

- Duplex scan
- CT (without contrast)
- Aortogram (with calibrated catheter)
- Spiral CT
- Intravascular ultrasound
- 3-D CT Reconstruction

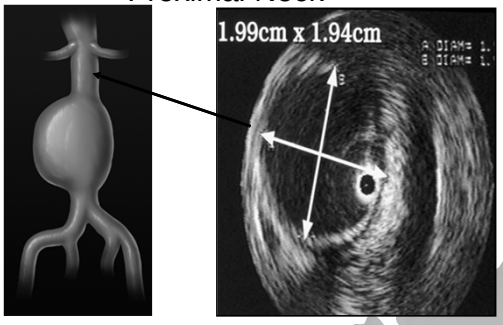


Numerous Pre-procedural Assessments



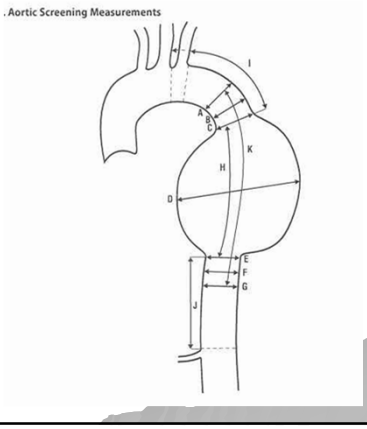
Intravascular Ultrasound

Proximal Neck



TAA

Pre-procedural Assessments



Postop Nursing Care

Management TAG/ELG vs Debranching

TAG & ELG

- Hourly neurovascular checks to extremities
- Immediate notification if decreased movement or sensation in legs-- may need to insert cerebral spinal catheter
- Lactate levels
- Pulmonary Toilet

TAG with debranching

- Volume resuscitate. Keep CVP high
- If hypotensive & hypovolemic, grafts can clot off
- Treat like a trauma or open abdominal surgery --- treat with hypotentsion with fluids not inotropes until tanked up.
- If Carotid arteries bypassed, hourly neuro checks

Postopertative Assessment, Complications & Care

- Endoleaks
- Extremity Ischemia
- Urinary Retention
- Renal Failure
- Bowel Ischemia
- Abdominal Compartment Syndroms
- Spinal Ischemia (TAA)
- Stroke
- Metabolic Acidosis
- Respiratory Complications

Endoleak

Aneursym sac remains pressurized

Endoleak Significance

Endoleak = Endopressure ≠ Protection

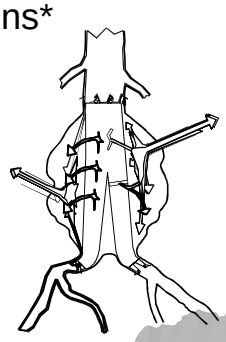
Perigraft Flow/Endoleak: Definitions*

Type I
Attachment leak

Type II
Branch flow

Type III
Defect in graft or modular disconnection

Type IV
Fabric porosity



* White et.al., Endoleak Classification, Journal of Endovascular Surgery, 1998;5:305-309

Post-operative Detection of Endoleak

Assessment of aneurysm diameter & volume

- Abdominal four view xrays POD #1
- CT with 3-D reconstruction
- Duplex Scan
- For severe endoleak = hemodynamic instability

Extremity Ischemia

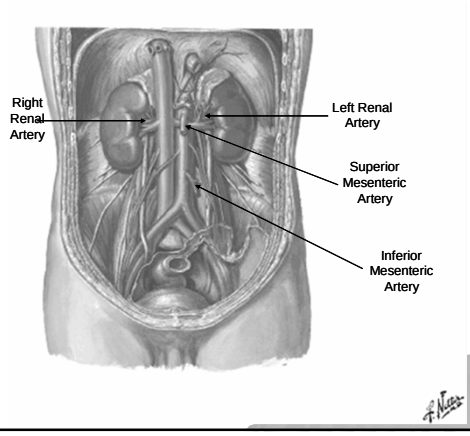
- Due to thombosis of graft or groin hematoma at insertion site
- Assess pedal pulses, *sensation*, color, and temperature of extremities every 15 minutes x 4 and then hourly.
- Assess for pain in the hip(s) or leg(s) during walking
- Ankle brachial indexes bilaterally POD #1

Urinary Retention

- Due to enlarged prostate
- Discontinue foley in OR or immediately upon admission to unit to prevent urinary retention

Renal Failure

- Due to occlusion of renal arteries by graft
- Due to atheroembolism
- Due to contrast induced nephropathy
  - 200 – 250 mg of contrast used per procedure case
  - HYDRATE preoperative



Bowel Ischemia

- Mesenteric Artery ischemia
  - **Due to occlusion or hypoperfusion of mesenteric artery ischemia**
  - **Due to atheroembolism**
  - **Will do bypass if think graft may cover mesenteric artery**
- Paralytic ileus
  - **Gastric distention**
  - **Retroperitoneal bleeding**
  - **Mesenteric ischemia**
  - **Drugs (narcotics**)

Bowel Ischemia

- Assess for
  - Loose stool or diarrhea
  - Bright red blood per rectum, blood streak stool
  - Abdominal pain out of proportion to physical findings
- Decompress bowel with nasogastric tube and keep NPO

Mesenteric ischemia

- Early diagnosis and treatment are essential to lower mortality
- Mortality generally exceeds 50%
- When ischemia is prolonged, irreversible intestinal necrosis may occur within hours
- Emergency abdominal exploration is indicated if bowel necrosis is suspected

Intra-abdominal hypertension (IAH) and Abdominal Compartment Syndrome (ACS)

Signs of Intra-abdominal hypertension (IAH) and Abdominal Compartment Syndrome

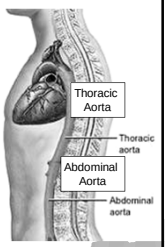
- Cardiac
  - Low CO with ↑ CVP/PAD
- Renal
  - Low urine output
- Pulmonary
  - Dysnpnea
  - ↓ tidal volumes
  - ↑ intrathoracic pressures
- GI
  - Nausea/vomiting
  - Abdominal pain
  - Abdominal distension
- Neuro
  - ↑ICP
  - Anxiety
  - Confusion
  - Lethargy

IAH and ACS

- In high risk patients, measure intra-abdominal pressure (IAP) via bladder pressure measurements
  - Get baseline
  - Measure every 2 – 6 hours
- IAH = IAP $\geq$ 12 mmHg
- ACS = IAP > 20 mmHg and associated organ failure/dysfunction

Spinal Cord Ischemia (SCI)

- The spinal cord like the brain
  - No room for anything but the cord and CSF
  - And it is unyielding to increased spinal pressures
- Paralysis
  - Occurs in about 3 - 6% of all repairs of the descending thoracic aneurysm
  - Due to interference in the blood supply to the spinal cord
- May occur immediately postop or from 1 – 21 days



Spinal Cord Ischemia

- Ischemia to the cord
  - Leads to cord edema
  - Can cause the lumbar ICP to rise & impede normal flow of CSF within the spinal cana
- Thoracic or lumbar spinal cord damage causes paraplegia
- Similar to muscular 'compartment syndrome'

Spinal Cord Ischemia (SCI)

- The mechanisms leading to SCI:
  - The interruption of multiple branch vessels that provide spinal cord perfusion.
- Hypotension - MAP < 70 - 90
  - Periop &/or postop
  - Can be a precipitating factor causing SCI

At risk for permanent and transient paraplegia

- Complicated Type B dissection
- Hybrid aortic procedures
- Aortic transection
- Chronic renal failure
- Smoking

Prevention of Spinal Cord Ischemia

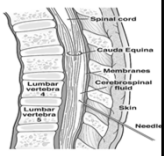
- Prevent Hypotension MAP < 70 - 90
  - Treat with fluids to keep CVP > 6

Treatment Spinal Cord Ischemia

- Drainage of the lumbar CSF can reduce the risk of cord damage when reducing pressure to < 7 – 10 mmHg
- Keep MAP > 90 - 99 mmHg

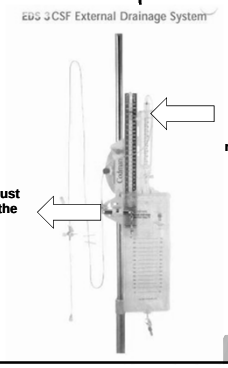
Lumbar Cerebral Spinal Fluid Drain

- Also called:
  - **Lumbar drain, Lumbar subarchonoid catheter, intrathecal catheter, CSF drain**
- Placed in the Lumbar Subarachonoid space
- Use for those at high risk for paraplegia
  - **Previous infrarenal repair**
  - **Long segments of spinal cord**
  - **Spinal pressure > 10 cm H_20**



Lumbar Cerebral Spinal Fluid Drain

Purpose
Prevent paraplegia



Lumbar CSF Drain Safety

- Place CSF transducer on opposite side of bed as hemodynamic pressure monitoring
- Must be a nonflush pressure system
- Turn drainage system off when getting patient up to chair
- Level after repositioning patient
- Remember to unclamp
- Aseptic technique is a must!

Spinal Ischemia Assessment

- Record CSF output hourly
- Notify MD if CSF drainage is > 20 – 30 ml/hr
- Note color of CSF
- Hourly spinal cord assessment for changes in sensation and/or movement

CSF Drainage

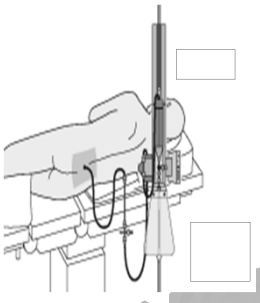
- Maintain CSF pressure 10 – 15 mmHg for the first 24 hours
- Then let rise to 15 mmHG
- If CSF pressure goes up above normal, blood flow to the spinal cord goes down, resulting in cord ischemia

Complications of CSF Drain

- Infection
- Overdrainage
  - Subdural hematoma
  - Herniation
- Spinal cord hematoma
- Headache
- Pneumocranium (from air entering system)

Complication of CSF Lumbar Drain <u>Overdrainage</u>

- Low pressure headache
- Radiculopathy
- Pneumocephalus
- **Sagging Brain / intracranial hypotension**
- Hemorrhage
- Subdural, intradural Hematoma
- Cranial nerve palsies
- Tension Pneumocephalus
- Brainstem herniation



Post removal of Lumbar drain

- Cap 24 hours prior to removal
- Assess for lower extremity weakness or loss of sensation
- SCI can occur up to 30 days post op.
- Teach patients to come to ED immediately for aggressive treatment if they notice any change, numbness, or weakness in their legs.

Stroke

- 4- 7% risk
- Routine neuro checks

Respiratory Complications

- Due to general anesthesia and smoking
  - Incentive Spirometry every 1- 2 hours while awake
  - Aggressive Activity
    - **HOB 30°**
    - **Chair when stable**
    - **Ambulate 200′ evening of surgery**
    - **Then Ambulate 4- 6 times per day**
- Left Pleural Effusion
  - Something may be bleeding

Admission ABGs

What would you do?

	Patient A	Patient B
ph	7.29	7.33
pCO_2	60	41
$p0_2$	132	100
TCO_2	31	22
O_2 %	98	98
BE	-1	-6

Type A Lactic Acidosis

Ongoing Metabolic Acidosis
means something is not being perfused

- Serum lactate levels used to assess the acid-base state and adequacy of tissue perfusion
- By product of anaerobic metabolism if tissue hypoxia exists

The Value of Lactate

Serial lactate levels predictor of perfusion

- Normal <2.5mmol/L
- Mild acidosis 2.5-4.9mmol/L (mortality 25-35%)
- Moderate acidosis 5.0-9.9mmol/L (mortality 60-75%)
- Severe acidosis > 10mmol/L (mortality > 95%)

Shoemaker, WC et al. Textbook of critical care. 1995. WB Saunders

Serum Lactate levels

- Serum Lactate levels every 4 hours x 24 hours
- Level will be around 4 – 5mmol/L on admission
- Lactate levels need to decrease
- May be the first indication that something is wrong

Discharge

- Abdominal – POD #1 from CVICU
- Thoracic -- POD #2 or 3
- Teaching
- 10 days post procedure the patient should be back to normal activities
- MRI conditional up to 3 Tesla

Follow-up

- CT scan at 1, 2, 6, and 12 months and then annually to assess for aortic growth
- Teaching
  - Avoidance of exertional activities
    - Betablockers blunt pressure spikes
  - Avoidance of extreme emotional upsets

References

- Desai ND, Pochettino A, Szeto W, et al. Thoracic endovascular aortic repair: Evolution of therapy, patterns of use, and results in a 10 year experience. J Thorac Cardiovasc Surg. 2011;142(3):587-594.
- Elefreriades JA, Farakas EA. Thoracic aortic aneurysm: Clinically pertinent controversies and uncertainties. J Am Coll Cardiol 2010;55:841-856.
- Gallager H. (2010) Intra-Abdomonial Hypertension. AACN Adv Crit Care: 21(2):205-217.
- Hiratzka LF, Bakris GL, Beckman JA et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STA/SVM guidelines for the diagnosis and management of patients with thoracic aortic disease: a report of the American College of Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. Circ 2010;121:e
- Methodist DeBakey Heart & Vascular Center. DeBakey Cardiovascular Journal. July – Sept 2011;7(3):1-56. (17 articles in this journal relating to endovascular stenting)
- Moser D, Riegal B. (2008). Cardiac Nursing: A companion to Braunwald's Heart Disease. St Louis MO: Sanders Elsevier.
- Steuer J, Eriksson MO, Nyman R, Bjorck M, Wanhainen A. Early and long-term outcome after thoracic endovascular aortic repair (TEVAR) for acute complicated type B aortic dissection. 2001;41:318-323.
- Svensson LG, Kouchoukos NT, Miller C et al. Expert consensus document on the treatment of descending thoracic aortic disease using endovascular stent-grafts. Ann Thorac Surg 2008;85:S1-41.
- Ullery BW, Cheung AT, Fairman RM, et al. Risk factor, outcomes, and clinical manifestations of spinal cord ischemia following thoracic endovascular aortic repair. J Vasc Surg 2011;54:677-684.