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Acute Ascending Aortic Dissection

Madhuri Rao MD
PGY-5
SUNY Downstate Medical Center

Case Presentation

- 60 yo M
- PMH: HTN (not on Meds), degenerative joint disease
- PSH: Nil
- Meds: Nil
- NKDA
- Social Hx: Smoker, previous illicit drug use

Case Presentation

History

- Presentation to outside hospital with 2 day h/o sharp chest pain, with radiation to back and jaw
- Elevated troponin, normal CXR, normal EKG
- Transferred to SUNY Downstate for cardiac catheterization

Case Presentation

Physical Exam at SUNY Downstate

- In no acute distress
- HR: 85-94 bpm
- BP: RUE – 146/96mmHg, LUE – 145/87mmHg
- RS: Clear
- CVS: Normal, no murmurs or gallop
- Abdomen: Soft, no pulsatile mass
- Neuro: No deficits
- No pulse deficits

Case Presentation

Lab Results

- BMP: 134/4.3/103/22/7/0.9/124
- CBC: 10/13/38/158
- Troponin: 0.3

EKG

- Normal sinus rhythm
- No acute changes

Cardiac Catheterization

- Non-obstructive CAD
- EF: 75%

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SECTRA

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RIS-Status: Final

Contrast: CONTRAST
Gantry: 0°
FoV: 354 mm
Slice: 2 mm
Pos.: 120 mm
Pat.pos.: FFS

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SECTRA

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RIS-Status: Final

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Pat.pos.: FFS

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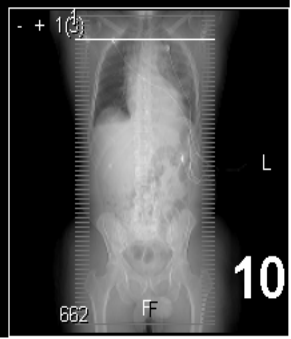

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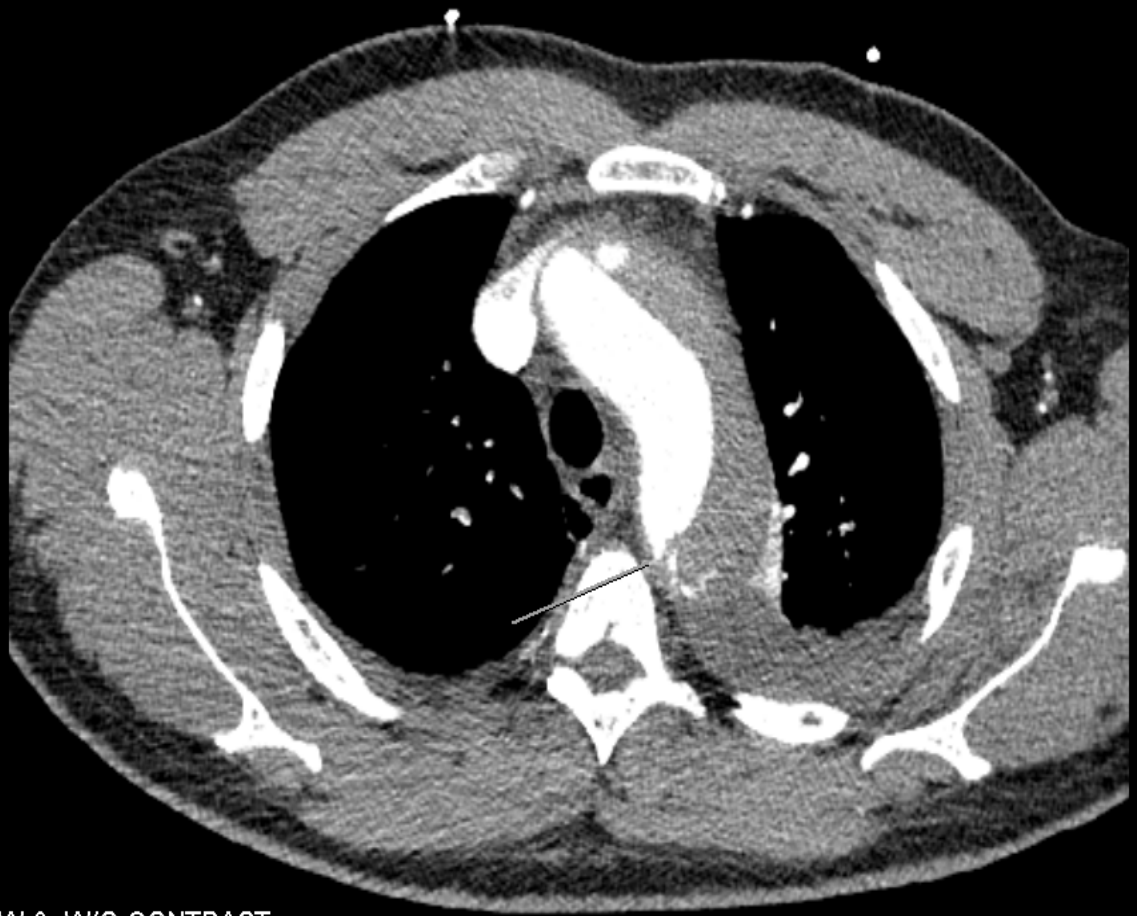

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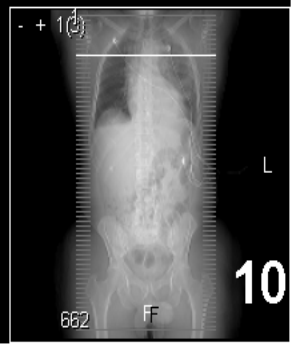

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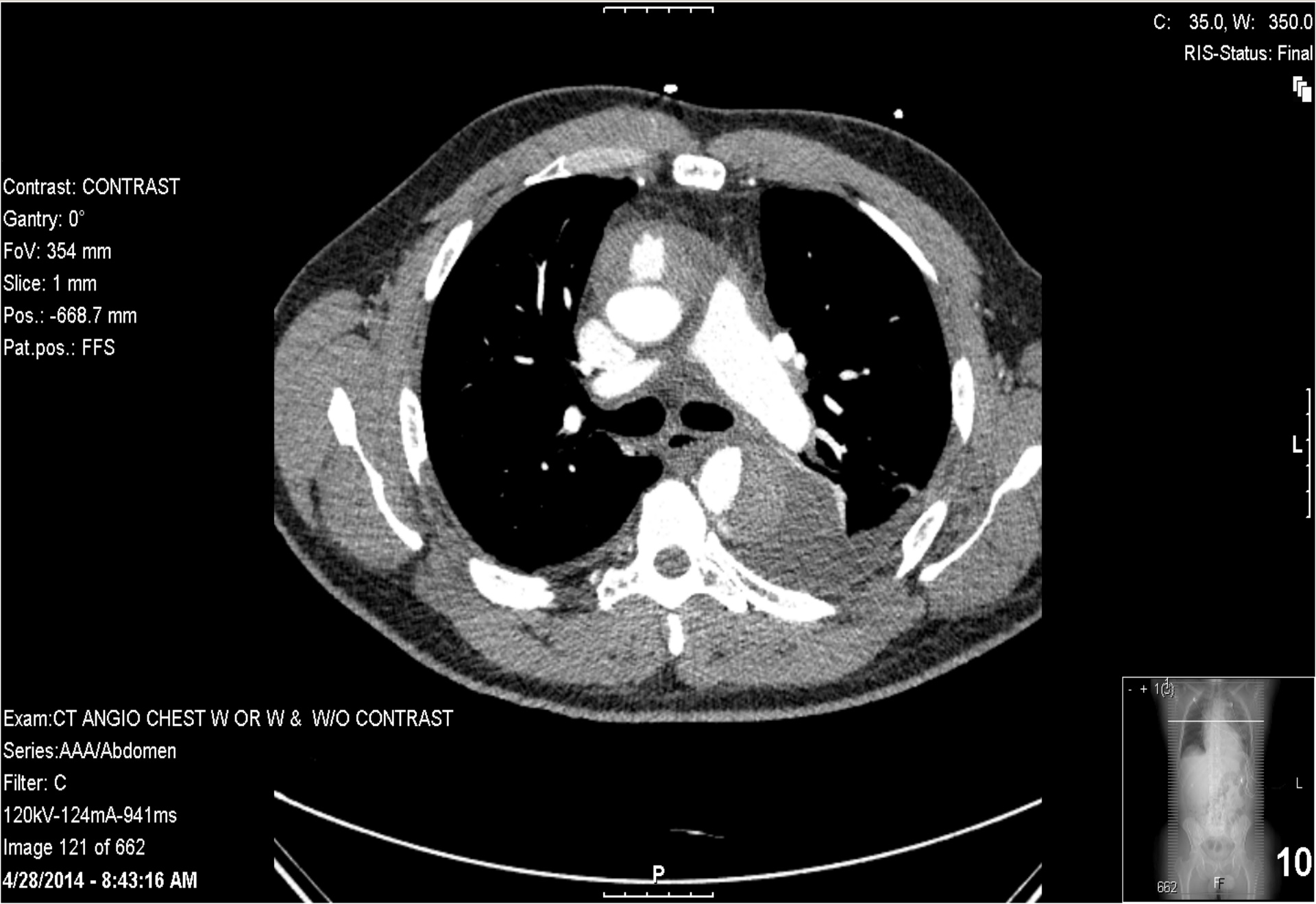

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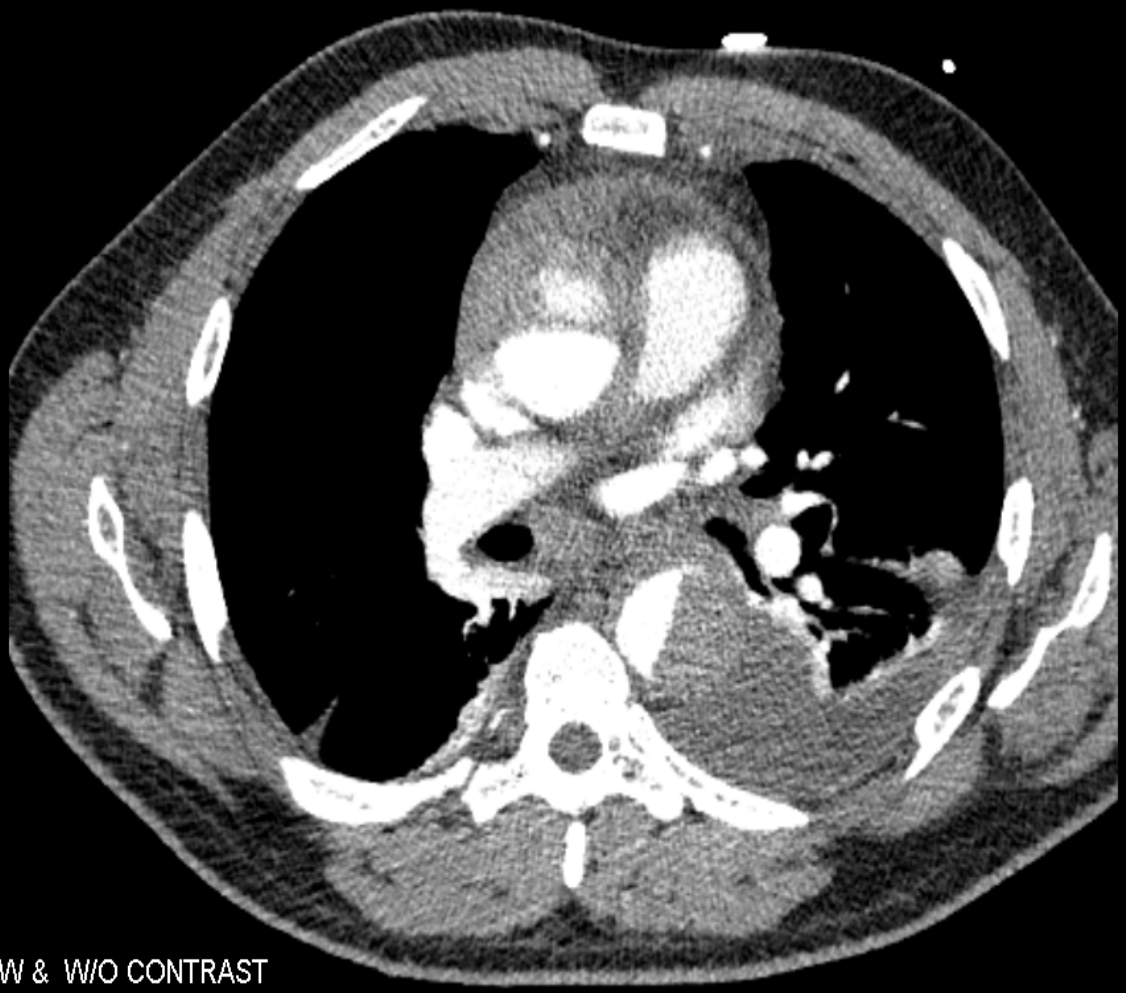

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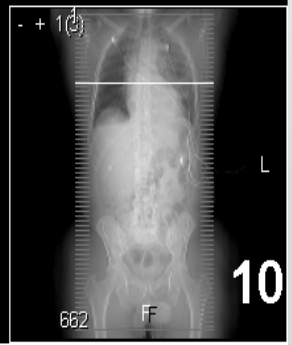

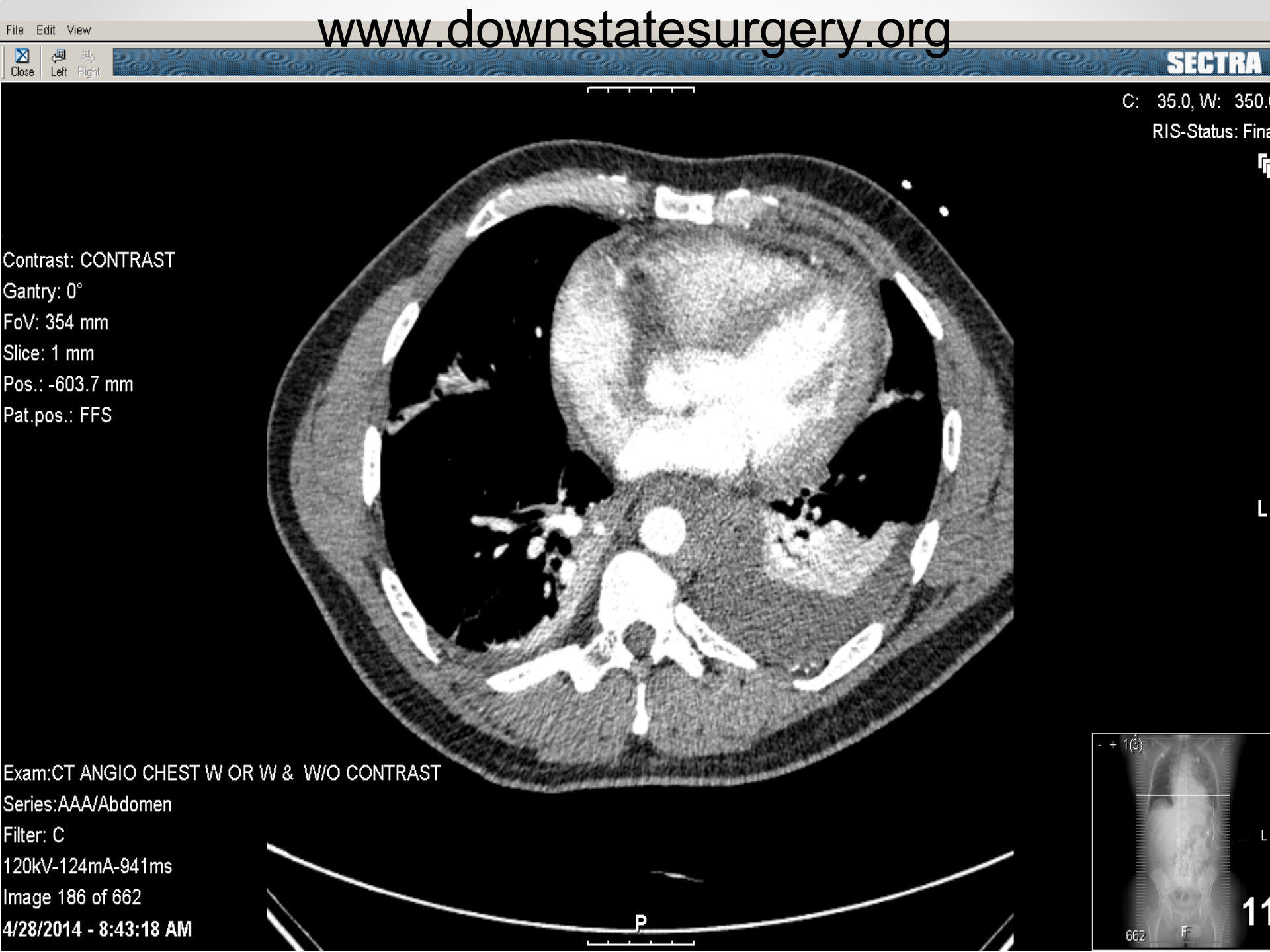

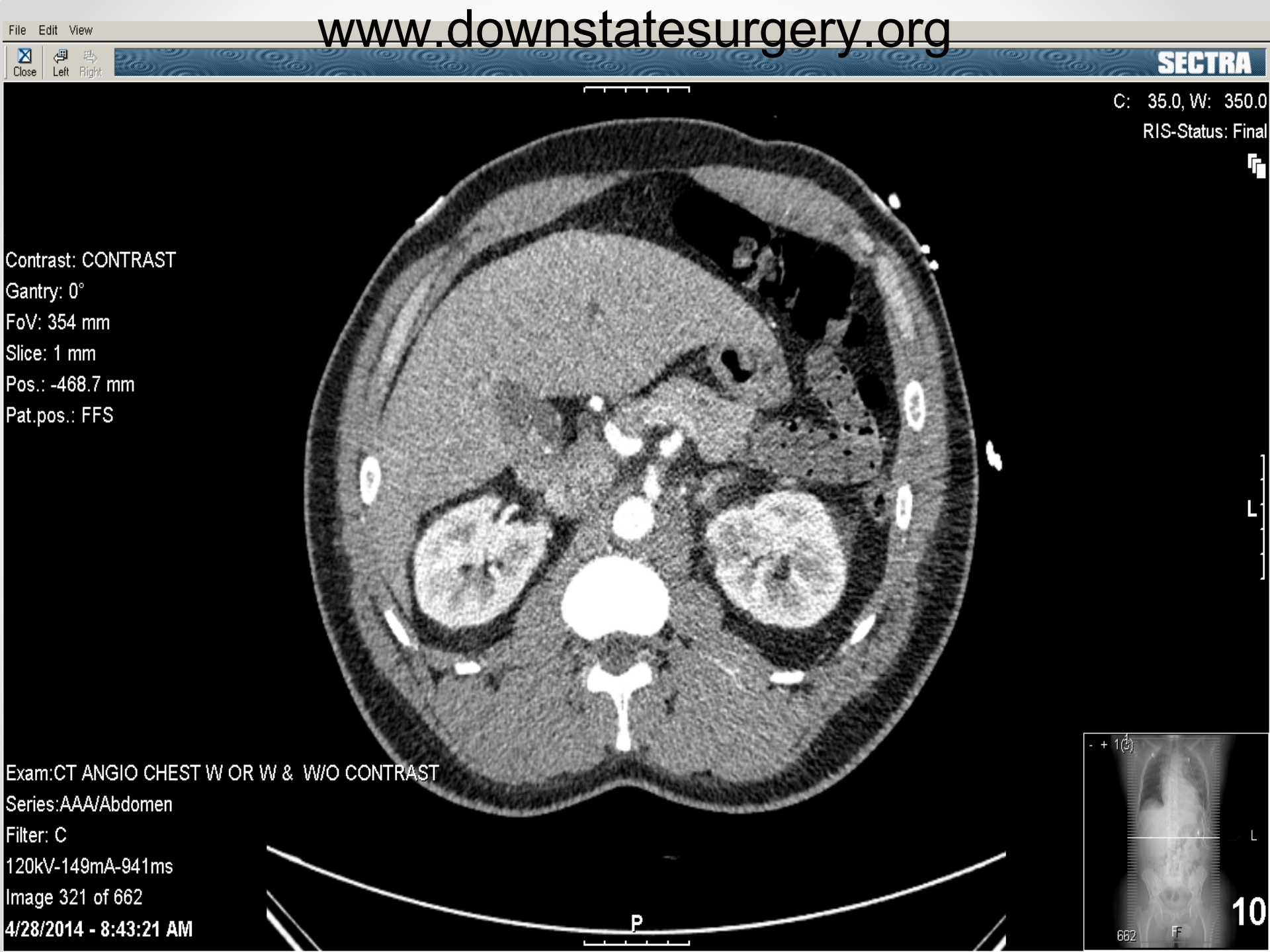

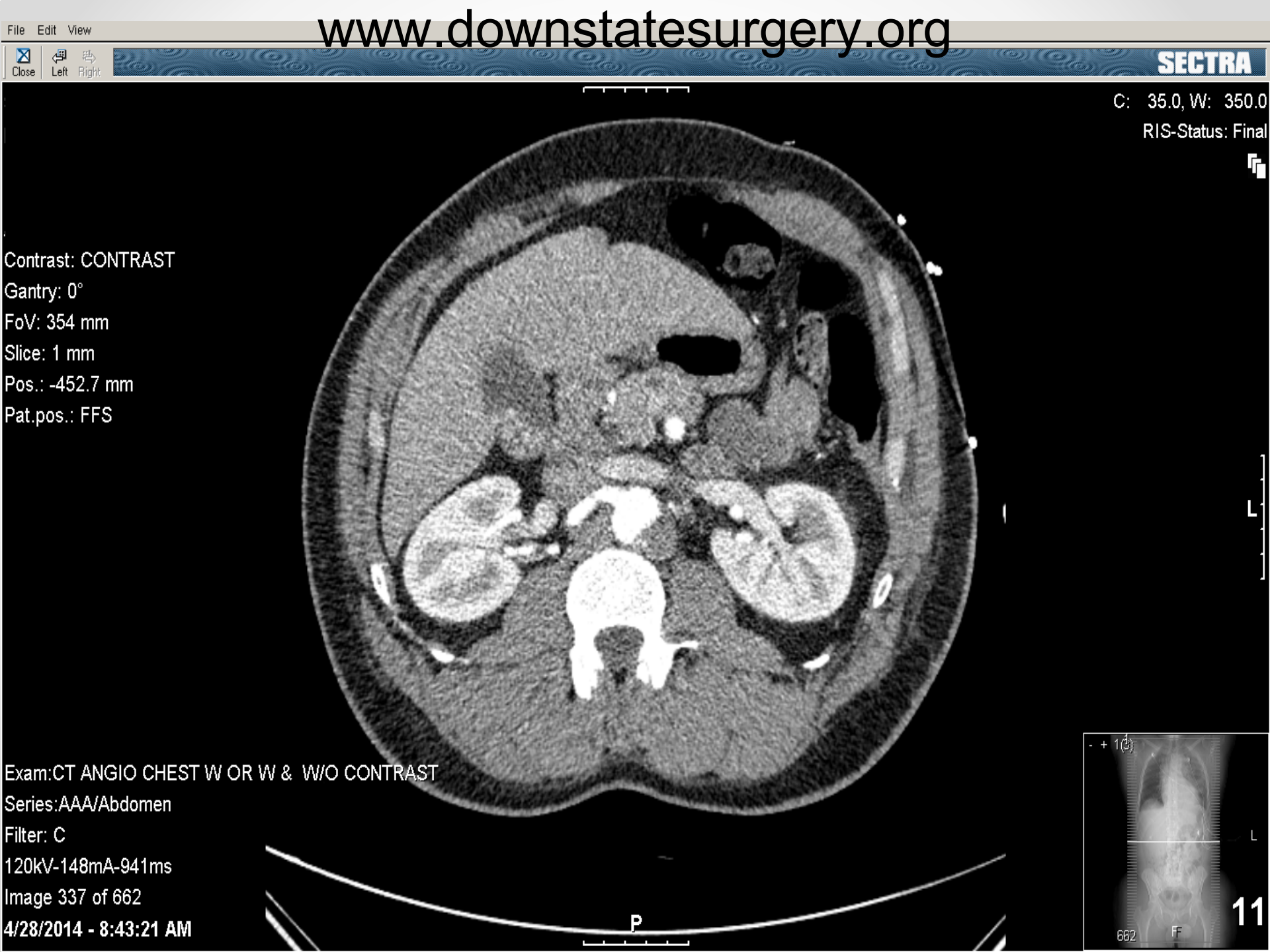

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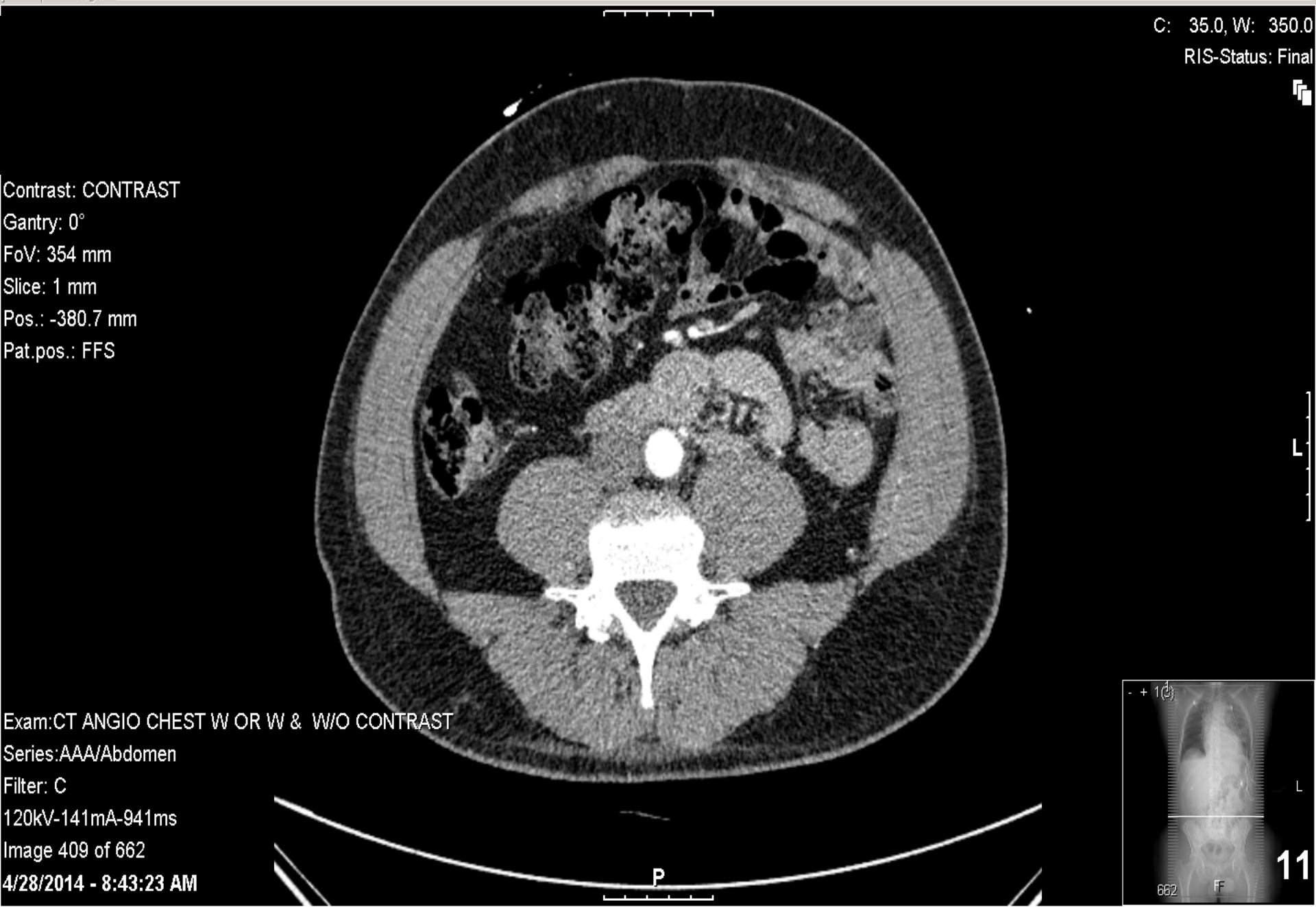


Case Presentation

Management

- CT surgery consult
- Transfer to CCU
- HTN control with esmolol and nitroprusside drip
- Plan for emergent operation

Case Presentation

OR Details

- Central venous catheter, pulmonary artery catheter, arterial line, Foley with thermistor
- Cardiopulmonary bypass
  - Arterial cannulation – right femoral artery
  - Venous cannulation – right atrium
- Approach – median sternotomy

Case Presentation

- Findings
  - Hemopericardium
  - Intimal tear proximal to origin of innominate artery
  - Extent of dissection – retrograde down to aortic root
  - Aortic valve – competent
  - RCA – not involved

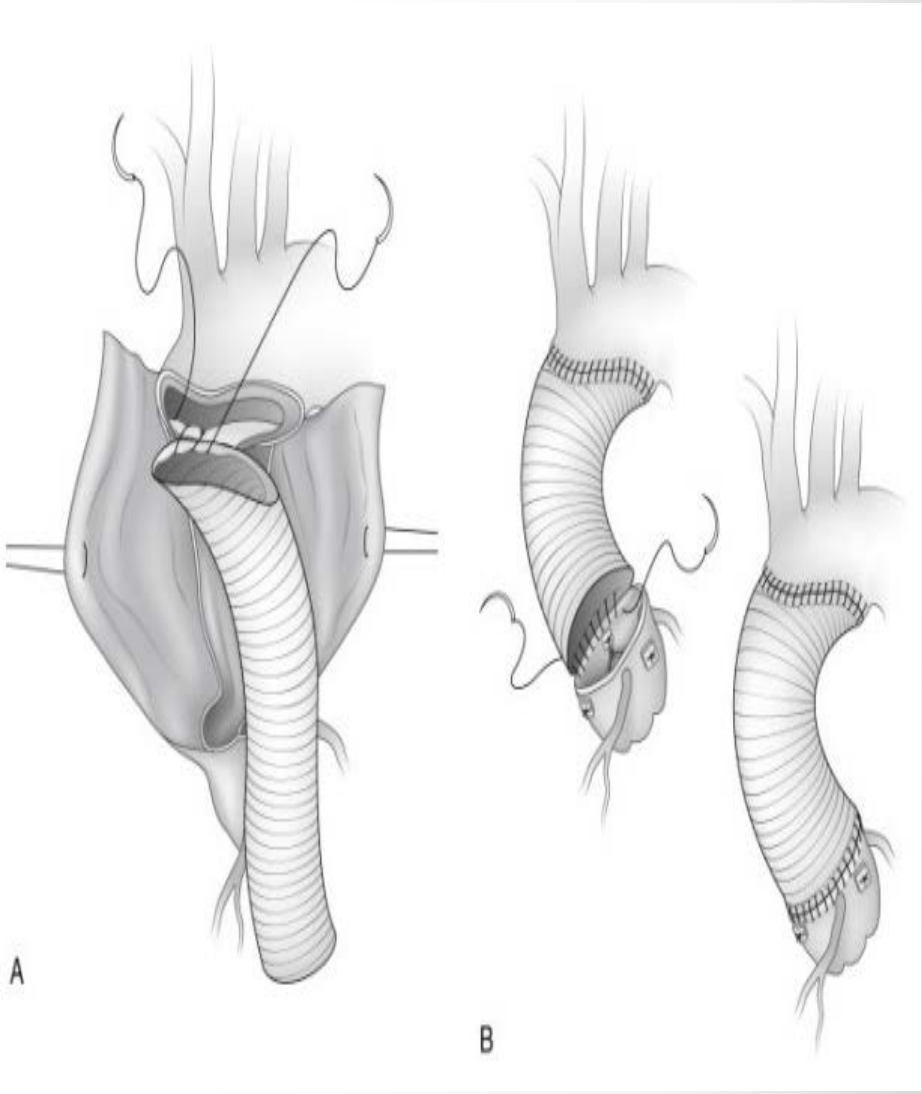
Case Presentation

Procedure – Critical Steps

- Cardiopulmonary bypass
- Aortic cross clamp in the middle of the dissection
- Deep hypothermic circulatory arrest (18-20 ºC)
- Exsanguination, removal of cross clamp and identification of tear
- Aorta trimmed proximally above ST junction, distally past the tear
- Evacuation of hematoma
- Layers approximated with Teflon strip

Case Presentation

- Hemiarch repair with 28mm Hemashield graft
  - Distal anastomosis
  - Active rewarming
  - Graft clamped
  - Proximal anastomosis
- De-airing, rewarming
- Off CPB
- Mediastinal and pericardial chest tubes
- Closure



Case Presentation

- CPB time: 178 minutes
- Aortic cross clamp time: 65 minutes
- Circulatory arrest time: 44 minutes

Case Presentation

Postoperative Course

POD 1-4

- High vent support
- BP control with clevidipine

POD 5-11

- Antibiotics for VAP
- Weaned and extubated
- PO beta blockers

POD 13

- Discharged to rehab unit

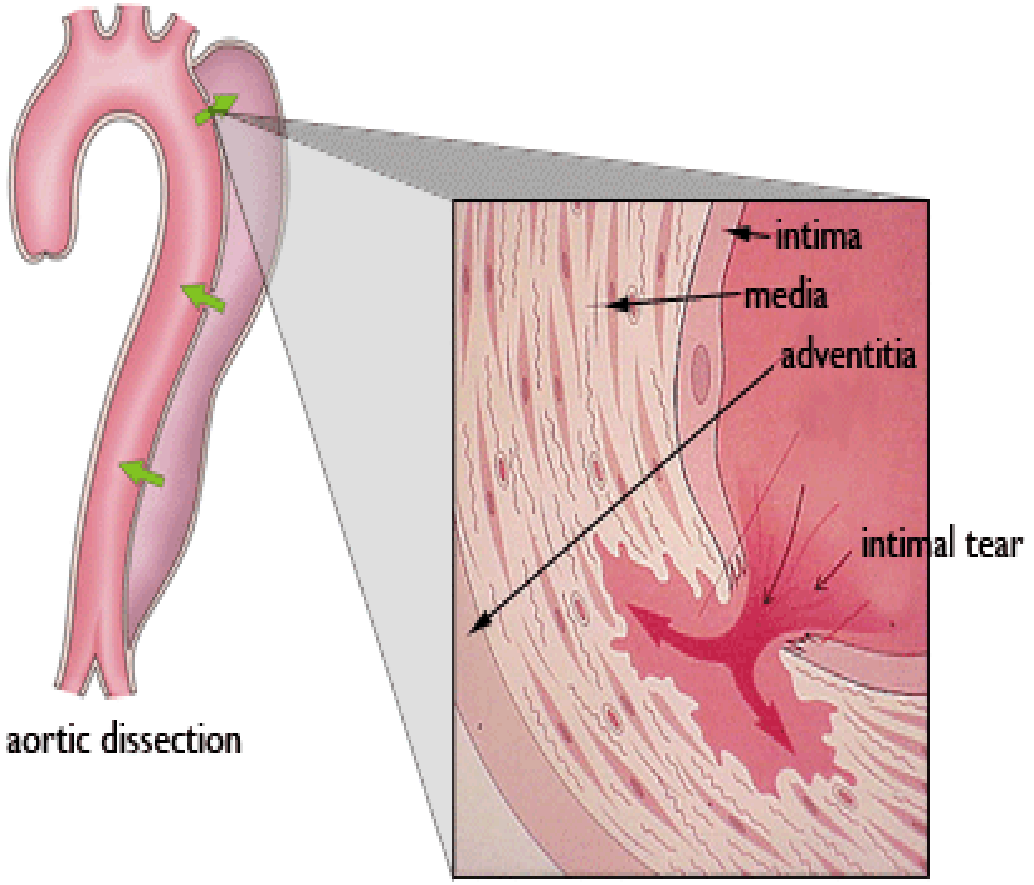
Discussion

- Definition
- History
- Classification
- Epidemiology
- Pathophysiology
- Clinical features
- Diagnosis
  - modalities and pitfalls
- Management
  - surgical principles
  - circulatory arrest and cerebral protection
  - operative techniques
- Prognosis and follow-up

Definition

Separation of the aortic media from the adventitia by pulsatile blood resulting in a false lumen in the aortic wall.

- Primary intimal tear
- Intramural hematoma
- Dissecting aneurysm



Historical Perspective

Postmortem Reports

1761 – Morgagni

1863 – Peacock (80 cases)

Antemortem Diagnosis

1934 – Shennan

1955 – Debakey (graft replacement, cardiopulmonary bypass for dissection)

Medical Management

1965 - Wheat and Palmer (anti-impulse therapy)

Further Advances

1970's – Griepp (hypothermic circulatory arrest)

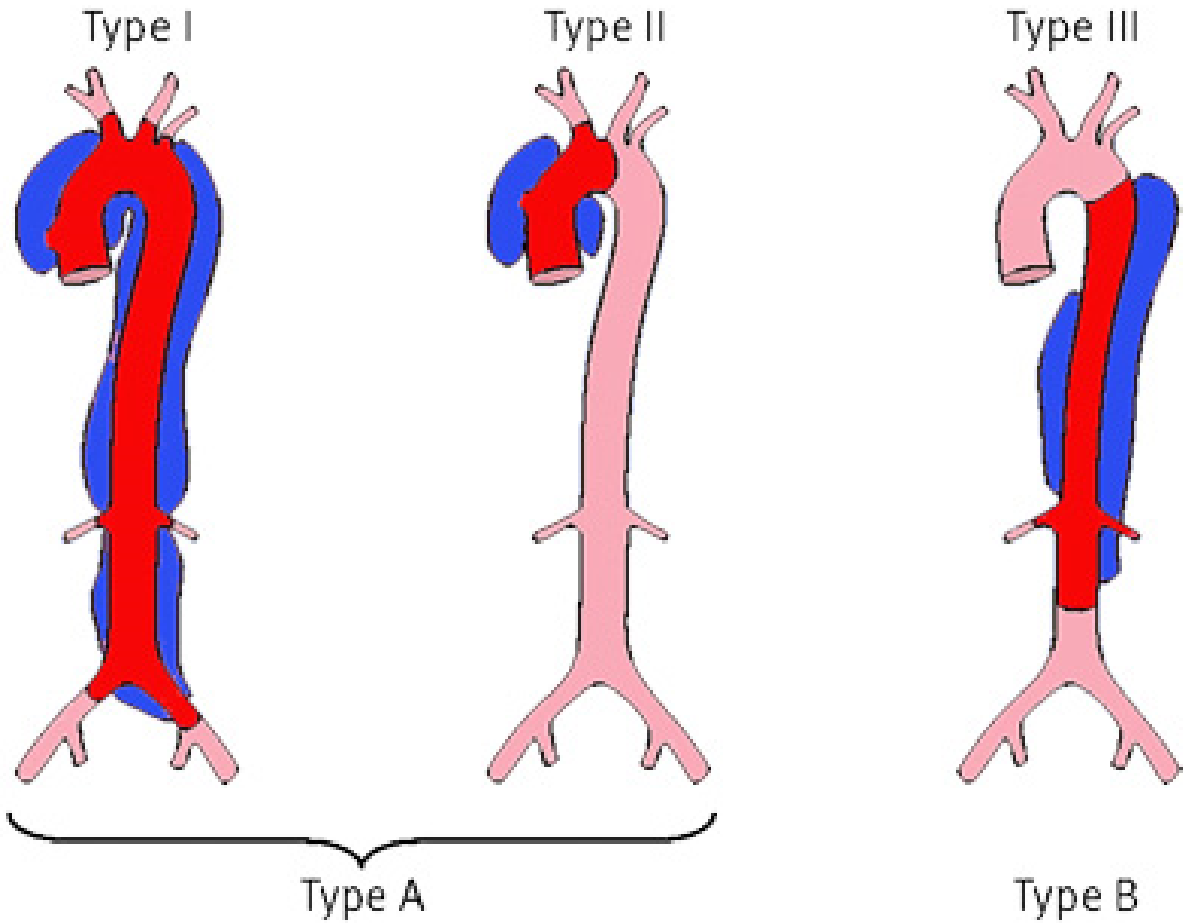
The New York Times
December 25, 2006

The Doctor's World; The Man on the Table Was 97, but He Devised the Surgery

In late afternoon last Dec. 31, **Dr. Michael E. DeBakey**, then 97, was alone at home in Houston in his study preparing a lecture when **a sharp pain ripped through his upper chest and between his shoulder blades**, then moved into his neck.

Dr. DeBakey, one of the most influential heart surgeons in history, assumed his heart would stop in a few seconds.

Classification



Acute – 14 days from symptom onset

Chronic – >14 days from symptom onset

Subacute – 2 weeks to 2 months

Epidemiology

- 50-69 yrs (63 yrs)
- 2/3 ascending, 1/3 descending
- 2000 new cases/yr
- Male:Female = 3:1

Risk Factors

- HTN
- Connective tissue disorders – Marfan's, Ehlers-Danlos, Loeys-Deitz
- Congenital abnormalities – coarctation of aorta, bicuspid aortic valve
- Prior aortic surgery
- Pre-existing aortic aneurysm
- Iatrogenic – CABG, cardiac catheterization
- Illicit drugs – crack cocaine
- Associations – Turner's syndrome, inflammatory vasculitis

Mortality and Morbidity

Mortality of 1-2%/hour (50% in 48 hrs, 95% in first month)

Natural History

- Intrapericardial rupture/cardiac tamponade
- Acute AVR- LVF
- Coronary ostial compromise – MI
- Malperfusion syndrome – Occlusion of cerebral/visceral branches
- Free rupture

- 10% - chronic, distal reentry
- False lumen thromboses
- Patent false lumen – false aneurysm

Pathophysiology

- Medial degeneration
- Primary intimal tear
- Intramural hematoma
- Propagation and reentry

Pathophysiology

The Concept of dP/dT

- Rate of change in left ventricular pressure over time
- Shear force
- Measure of force of ventricular contraction
- Medical management - Reducing aortic wall stress to limit further propagation and rupture of the dissection.

Clinical Features

- Pain – chest, back, jaw
- Recurrent pain = rupture
- Shortness of breath
- Neurologic – syncope, CVA, spinal cord syndromes, focal neurological deficits
- Cardiac – HTN, tamponade, MI, aortic regurgitation
- Ischemic – pulse deficits in carotids or extremities
- BP difference > 20mmHg between right and left arm

Diagnosis

- **High index of suspicion**
- Upto 2/3 of patients undergo > 1 test before diagnosis
- Factors a/w delay in diagnosis
  - Demographics – female, non-tertiary hospital, prior cardiac surgery
  - Atypical symptoms – fever, mild/no pain, CHF
  - Initial diagnostic test – abnormal EKG, MRI, cardiac catheterization
- Quickest diagnosis with CT angiogram

Moore AG, et al.Choice of computed tomography, transesophageal echocardiography, magnetic resonance imaging and aortography in acute aortic dissection: International Registry of Acute Aortic Dissection. *Am J Cardiol*. 2002;89
Correlates of Delayed Recognition and Treatment of Acute Type A Aortic Dissection: The International Registry of Acute Aortic Dissection (IRAD), Circulation 2011

Diagnosis

Goal of Diagnostic Tests

- Primary tear location
- Extent of dissection
- Status of false lumen
- Branch compromise

Diagnosis

- EKG
  - RCA involvement – inferior MI
  - Cardiac tamponade – low voltage
- CXR
  - Wide mediastinum (50%)
  - Displacement of intimal calcification
  - Widening of aortic knob
  - Double aortic shadow
  - Pleural effusion

Diagnosis

- TTE
- TEE
  - Noninvasive, bedside, no contrast
  - Operator dependent, can't assess branch vessels & extent beyond celiac
  - Aortic valve function
  - Flow characteristics
  - LV size and function
  - Ostia of main coronaries
- CTA
- MRI
- Aortography

TABLE 45-3 Sensitivity and Specificity of Various Imaging Modalities Useful for the Diagnosis of Thoracic Aortic Dissection

Imaging study	Sensitivity	Specificity
Aortography	80%–90%	88%–95%
Computerized tomography (CT)	90%–100%	90%–100%
Intravascular ultrasound (IVUS)	94%–100%	97%–100%
Echocardiogram		
Transthoracic	60%–80%	80%–96%
Transesophageal	90%–99%	85%–98%
Magnetic resonance imaging (MRI)	98%–100%	98%–100%

Green GR, Kron IL. Aortic Dissection.
In: Cohn LH, Edmunds LH Jr, eds. Cardiac Surgery in the Adult. New York: McGraw-Hill, 2003:10951122

Diagnosis

- Abrupt onset of thoracic or abdominal pain with a tearing or sharp quality
- A pulse deficit or >20mmHg difference in BP between the right and left arms
- Mediastinal widening on CXR

All three findings absent – low probability (7%)

Pulse or BP abnormality/ any combination – High probability (83%)

Management

Goals

- Early operative intervention
- Decrease mortality
- Limit end organ damage
- Repair ascending aorta prior to peripheral arterial complications (<10% needing intervention)

Management

SURGICAL EMERGENCY

A B C

- Intubate if unstable
- 2 large bore IV's
- Place the patient on a cardiac monitor
- CBC, electrolytes, cardiac markers, coags, type and cross
- EKG and CXR
- If suspicion is strong, consult cardiothoracic surgery while diagnostic testing is underway

Management

- Foley, A-line, central venous catheter
- Intensive anti-impulse treatment – lower MAP and dP/dT (SBP 100-120 mmHg, HR 60 bpm)
  - IV beta blocker(esmolol)/calcium antagonist
  - Followed by vasodilator
  - Pain control with morphine
- If hypotensive with tamponade – Pericardiocentesis- **Only to bring BP up enough to perfuse vital organs**

Surgical Principles

- Replace ascending aorta to prevent rupture, tamponade
- Identification and resection of intimal tear
- Reconstitute dissected layers/obliterate false lumen
- Complete transection and full thickness aorta to graft anastomosis
- Valve sparing aortic root replacement vs. AV reconstruction or replacement if severe aortic regurgitation

Technical Aspects - Cerebral Protection

Hypothermic Circulatory Arrest

- Cooling the brain down to hypothermic temperatures sufficient to reduce brain metabolic requirements to an extent that blood flow can be completely interrupted.
- A bloodless operating field
- Extended surgical time limit
- Pioneered by Barnard and Schire, Borst
- Popularized by Griepp in 1970s

Technical Aspects - Cerebral Protection

Consensus on hypothermia in aortic arch surgery

Tristan D. Yan, Paul G. Bannon, Joseph Bavaria, Joseph S. Coselli, John A. Elefteriades, Randall B. Griepp, G. Chad Hughes, Scott A. LeMaire, Teruhisa Kazui, Nicholas T. Kouchoukos, Martin Misfeld, Friedrich W. Mohr, Aung Oo, Lars G. Svensson, David H. Tian

- Profound hypothermia ≤14 ℃
- Deep hypothermia 14.1-20 ℃
- Moderate hypothermia 20.1-28 ℃
- Mild hypothermia 28.1-34 ℃

Technical Aspects - Cerebral Protection

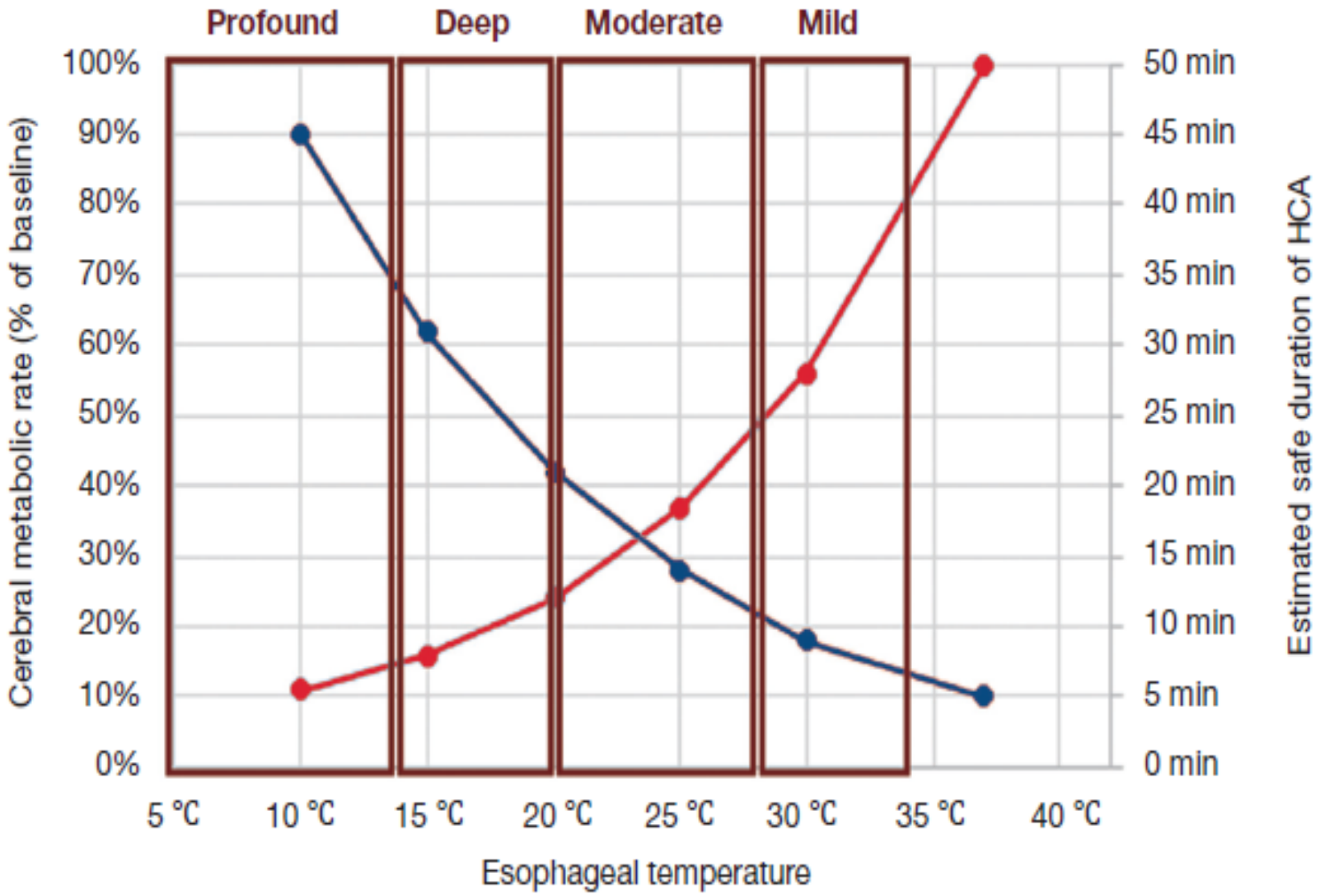
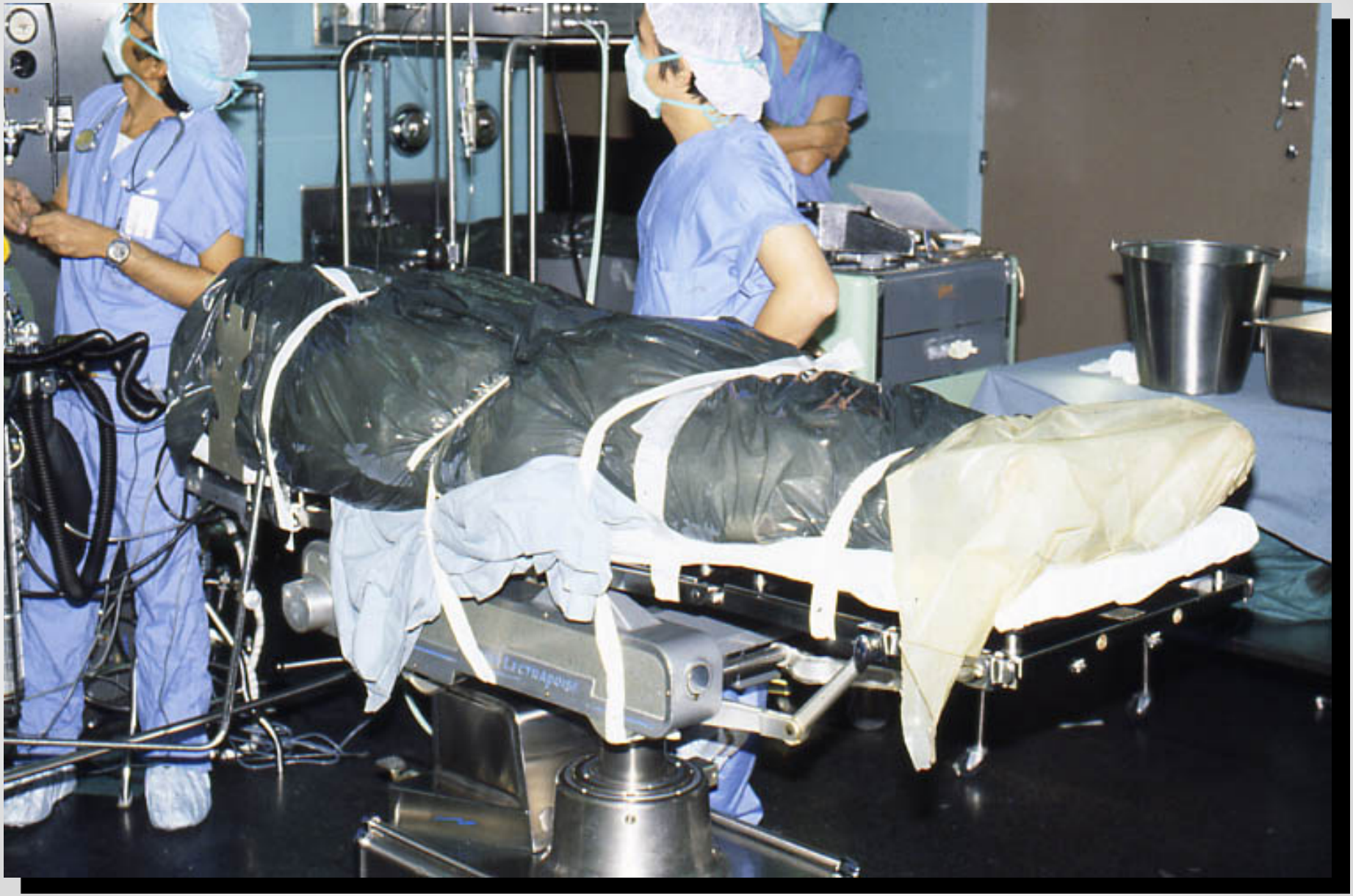
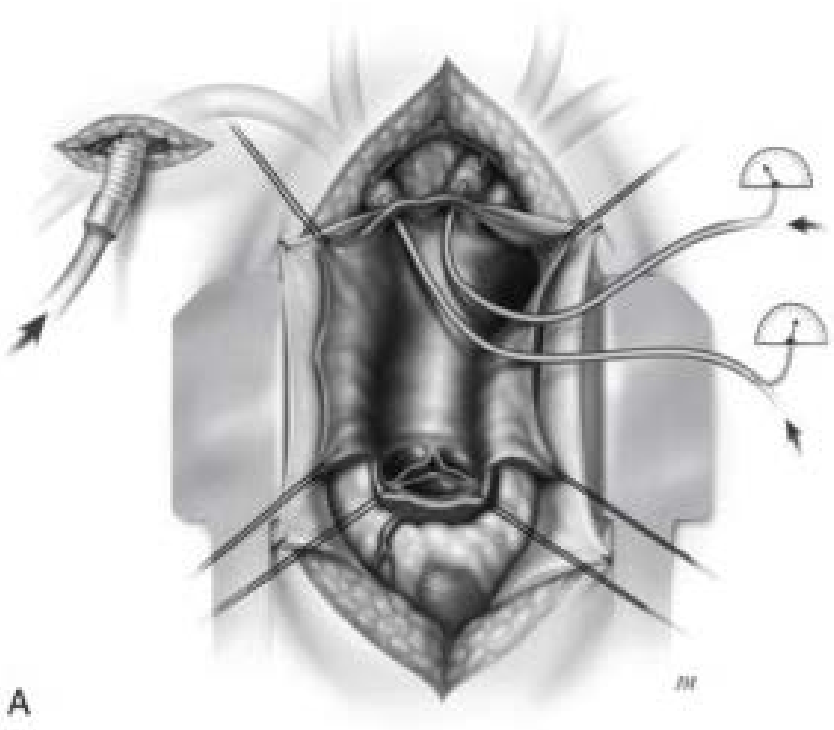


Figure 3 Cerebral metabolic rate, as percentage of baseline, at various esophageal temperatures, and estimated safe duration of HCA. Proposed categories are superimposed in dark red. (Modified from McCullough *et al.*)

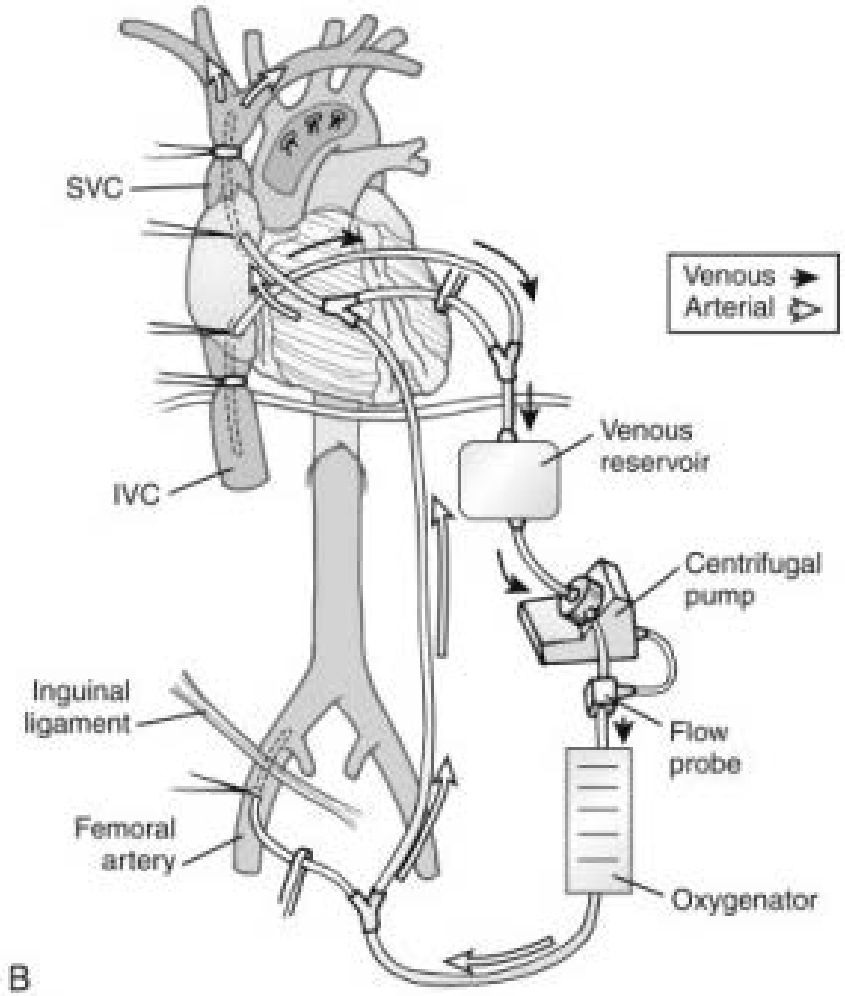
Surgery of Thoracic Aorta



Technical Aspects - Cerebral Protection



Antegrade Cerebral Perfusion



Retrograde Cerebral Perfusion

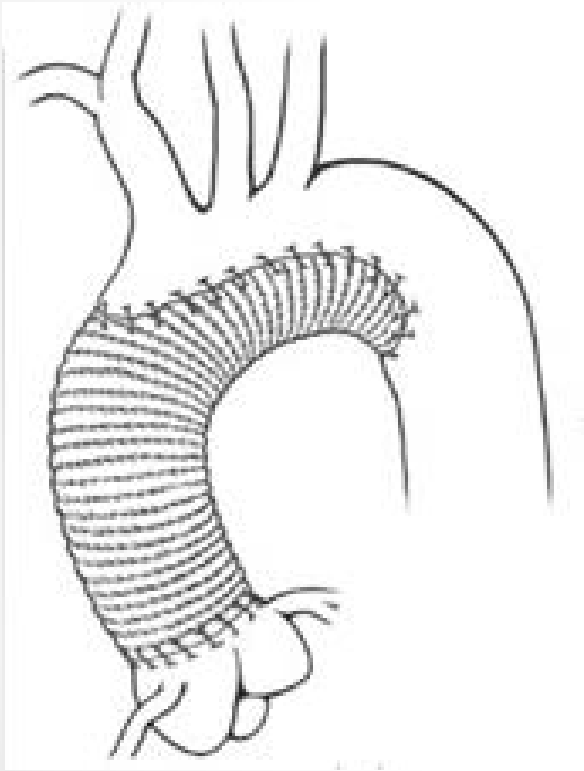
Technical Aspects - Cerebral Protection

Stanford Brain Protection Protocol

Population	Protective Measures
All patients	Electroencephalogram silence
	Temperatures less than 20° C
	Head packed in ice
	Mannitol prime and after arrest
	Alpha-stat pH control
	Leukoguard filter
	CO_2 flooding of field
	Thiopental 5 mg/kg 5 min before arrest
	Lidocaine 200 mg before arrest
	Magnesium sulfate 2 g
	Centrifugal pump
	Membrane oxygenator
	Closed-circuit bag venous reservoir
	Pre-bypass plasmapheresis
	Routine use of cell saver device

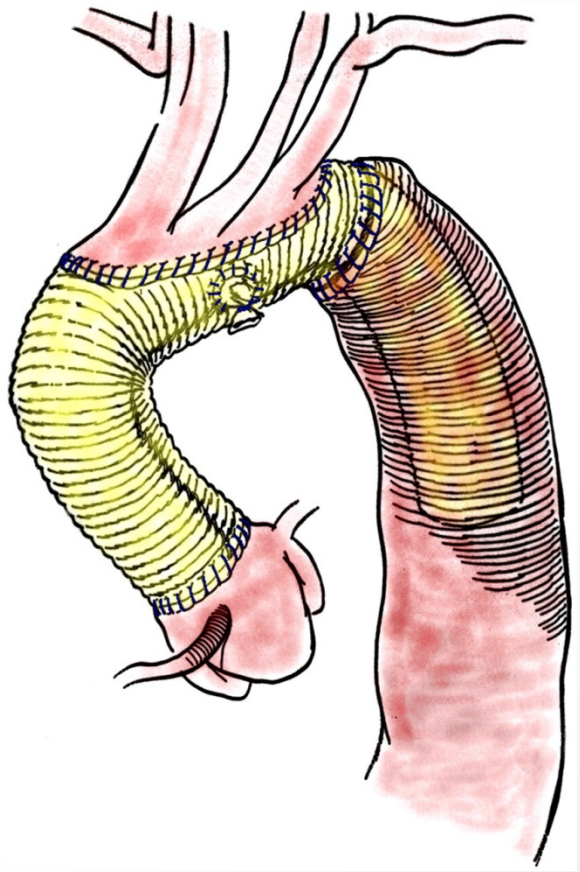
Operative Techniques

Hemiarch Replacement



Total Arch Replacement (Elephant trunk procedure)

- Tear on greater curve, arch rupture, aneurysm



Operative Technique

Aortic Root Replacement

- Dissection related destruction
- Marfan's
- Dilated sinuses, aortic annulus
- Direct extension into coronary ostium
  - Root replacement with reimplantation

Aortic Valve Replacement

- Abnormal aortic valve
- Not amenable to repair

Prognosis

Bad Prognostic Indicators

- Age > 70 yrs
- Shock at presentation
- Renal failure
- Pulse deficit
- MI
- Previous AVR
- Stroke at presentation

Survival Post Surgery (IRAD data)

- 1 yr – 96%
- 3 yrs – 91%
- 5 yrs – 68%
- 10 yrs – 52%

Follow up

- Baseline post op CTA/MRI, serial CTA/MRI (3, 6, 12 mos)
- TTE annually – aortic root and valve function
- Cardiologist f/up and screening imaging every 1-2 yrs (dissection progression, redissection, aneurysm formation)
- Avoid heavy physical activity
- Lifelong beta blockers / calcium channel antagonist
- Avoid ACE Inhibitors (increase dp/dt)

Summary

- Type A aortic dissection is a surgical emergency
- High index of suspicion for timely diagnosis
- CT angiogram as first test if suspicious history
- Management
  - Airway, Breathing, Circulation
  - BP control (anti-impulse therapy)
  - Early involvement of CT surgery team
- Technical aspects
  - Cerebral protection with hypothermic circulatory arrest, antegrade or retrograde cerebral perfusion
- Close postoperative follow up
  - Significant delayed mortality

References

Slide courtesy: Dr. Burack

Sellke: Sabiston and Spencer's Surgery of the Chest, 8th ed.

International Registry of Acute Aortic Dissection

Green GR, Kron IL. Aortic Dissection. In: Cohn LH, Edmunds LH Jr, eds. Cardiac Surgery in the Adult. New York: McGraw-Hill, 2003:10951122

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Correlates of Delayed Recognition and Treatment of Acute Type A Aortic Dissection: The International Registry of Acute Aortic Dissection (IRAD), Circulation 2011

Consensus on hypothermia in aortic arch surgery. Yan TD, Ann Cardiothorac Surg 2013;2(2):163-168

Aortic Arch Replacement: the conventional 'elephant trunk' technique. Schepens MA, European Association of Thoracic and Cardiovascular Surgery

Questions

1. **Which of the following statements is false regarding aortic dissection?**

A. Timely diagnosis is critical because the mortality is 1% to 2% per hour during the first 24 to 48 hours after acute dissection.

B. Given the widespread availability of computed tomography scanners, most such patients receive prompt diagnoses.

C. If the dissection is not diagnosed, the mortality rate for ascending aortic dissection approaches 90% at 3 months.

D. Acute dissection of the thoracic aorta is more common than a ruptured abdominal aortic aneurysm.

Questions

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C. If the dissection is not diagnosed, the mortality rate for ascending aortic dissection approaches 90% at 3 months.

D. Acute dissection of the thoracic aorta is more common than a ruptured abdominal aortic aneurysm.

Questions

2. A DeBakey type III (Stanford type B) thoracic aortic dissection:

A. originates in the ascending aorta

B. requires prompt operation to prevent aneurysm rupture

C. most often occurs in association with Marfan syndrome

D. is usually accompanied by profound hypotension

E. is best diagnosed by transesophageal echocardiography (TEE)

Questions

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Thank You