Echocardiographic Evaluation of the Aorta

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The Aorta: What to Evaluate

- Dimensions / shape
- Atherosclerotic disease
- Presence / absence of aneruysm
- Presence / absence of dissection
- Associated anatomy
  - Bicuspid aortic valve

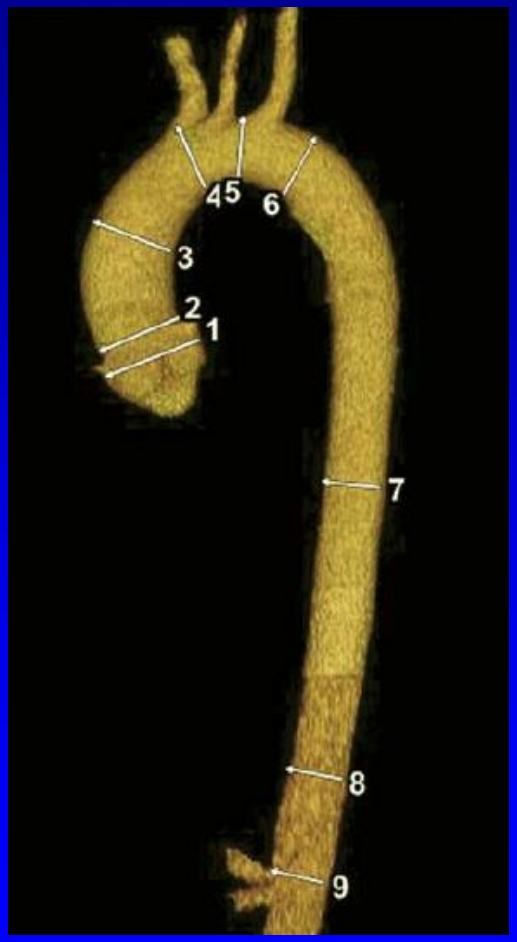
The Aorta: When to Evaluate

- Symptoms suggestive of aortic disease
- Known predisposing factor for aortic disease
- Other test (CXR etc.) suggests aortic disease
- First degree relatives of patients with aortic disease

Imaging Techniques

Technique	Extent	Atheroma	Dissection	Associated Disease	Limitations
TTE	AV, Proximal aorta & arch	No	Limited	All cardiac anatomy, AI, LV function, PEF	Limited visualization
TEE	Aortic Valve to diaphragm	Yes	Accurate as viewed	All cardiac anatomy, AI, LV function, PEF	Limited to above diaphragm
CT	Aortic valve to femorals	Yes	Accurate	Some anatomy, PEF, LV function	Dye load, radiation, motion artifact
MRI	Aortic valve to femorals	Yes	Accurate	Most cardiac anatomy, AI, LV function, PEF	Patient tolerance and safety
Angiography	Aortic valve to femorals	Yes	Accurate	Nada	Invasive, restricted availability

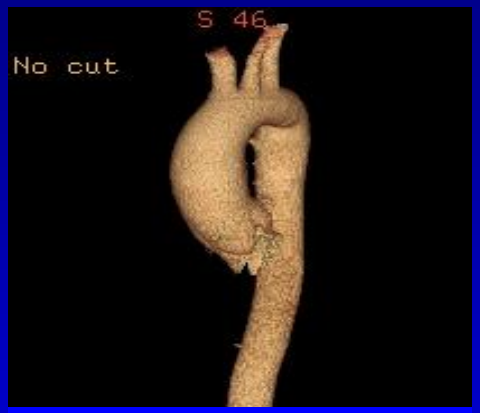
Measuring the Aorta



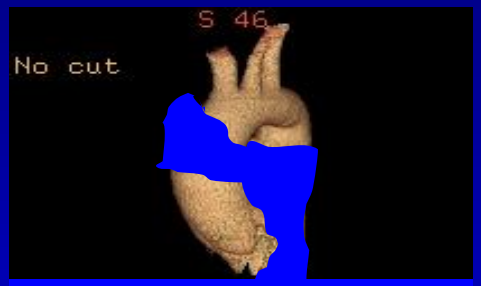
- Measure and record at multiple, predefined sites
- “Aortic root” = biggest proximal dimension
- Most patients will require at least one evaluation of the entire aorta
- Tailor subsequent assessment to area of disease
- Measure internal dimensions on TEE, external with CT

Evaluating the Aorta: Which Technique Sees What

CT / MRI



TEE



TTE

“Acute Aortic Syndrome”

- Acute aortic dissection
  - Type A, B
- Acute intramural hematoma
- Rapidly expanding aneurysm
- Ruptured Aneurysm
- Penetrating ulcer

WG: 24 YO male

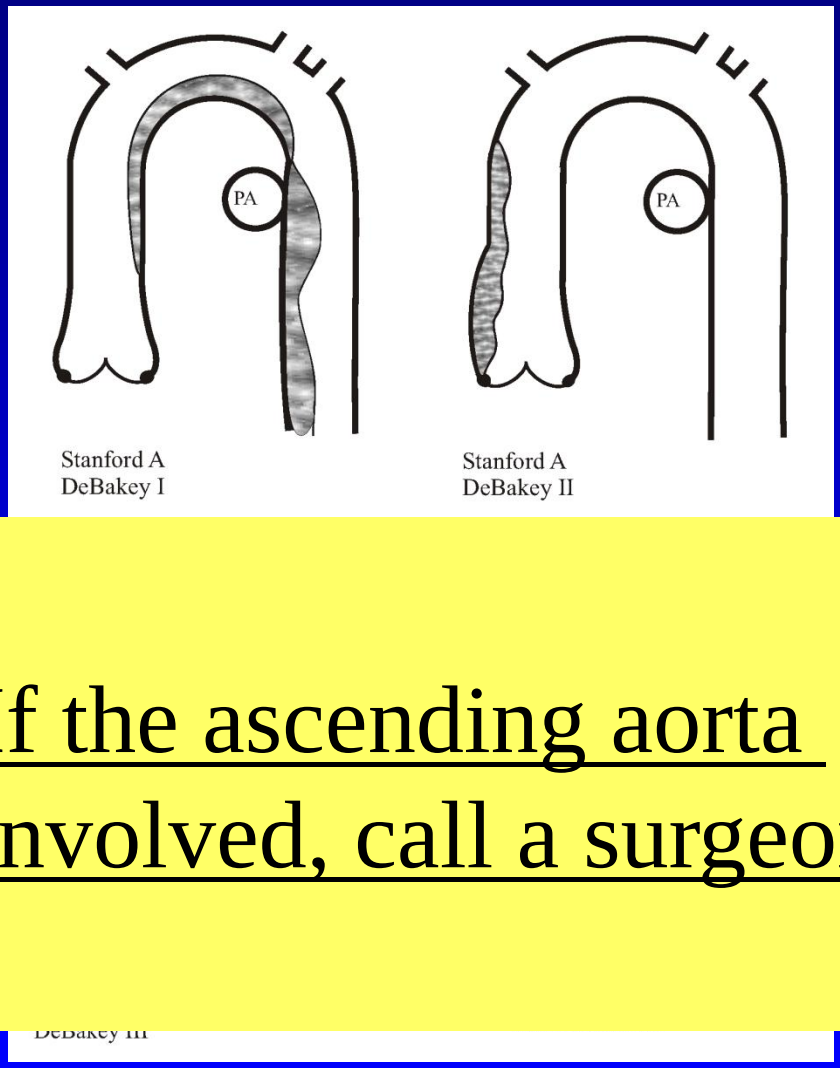
- Told of dilated aorta at age 18
  - No meds and no follow-up
- Sudden chest pain at work
- Cardiac arrest in ambulance
- CPR not successful in ED
- Autopsy: type I dissection

SJ: 54 YO male

- PMHx = HTN, type 2 diabetes
- Dull retrosternal pain for 40 minutes
  - No
- Disch
- Subse
- Autopsy: type I dissection

Litigation Pending

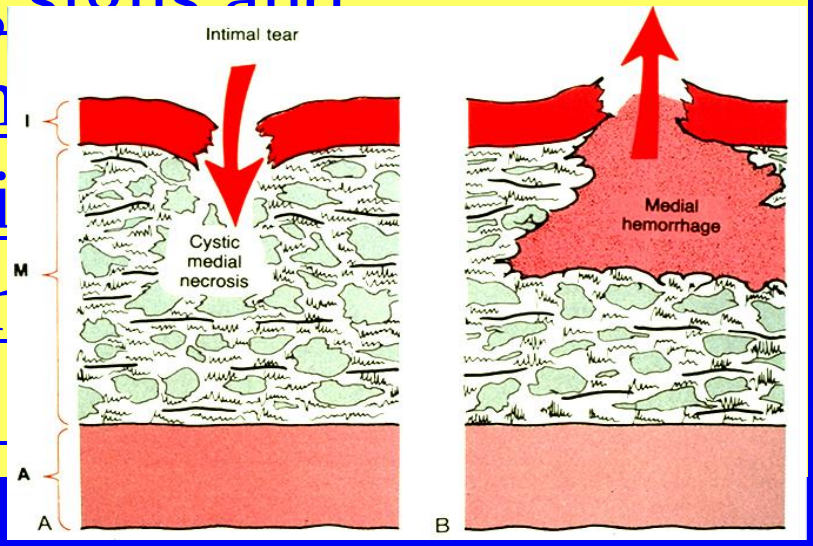
Classification of Aortic Dissection



If the ascending aorta is involved, call a surgeon!

Classic Dissection vs.. Intramural Hematoma (IMH)

Presenting signs and
symptoms, n
strategi
outcom
virtually



Echocardiography 6th Edition

Aortic Dissection: High Risk Conditions

- **Marfan Syndrome**
- **Connective tissue disease***
- **Family history of aortic disease**
- **Known aortic valve disease**
- **Recent aortic manipulation (surgical or catheter-based)**
- **Known thoracic aortic aneurysm**
- **Genetic conditions that predispose to TAD†**

* Loeys-Dietz syndrome, vascular Ehlers-Danlos syndrome, Turner syndrome, or other connective tissue disease.

†Patients with mutations in genes known to predispose to thoracic aortic aneurysms and dissection, such as *FBN1, TGFBR1, TGFBR2, ACTA2,* and *MYH11*.

Aortic Dissection: Incidence

- Incidence estimated at 5-20/million
- Anticipate ~ 5000/year in U.S.
  - 500,000 acute MI/year
- Mortality for type A dissection
  - 1% / hour in first 24 hours
  - 75 – 90% at 30 days
- Current data suggest incidence may be higher and mortality a bit lower

Legends

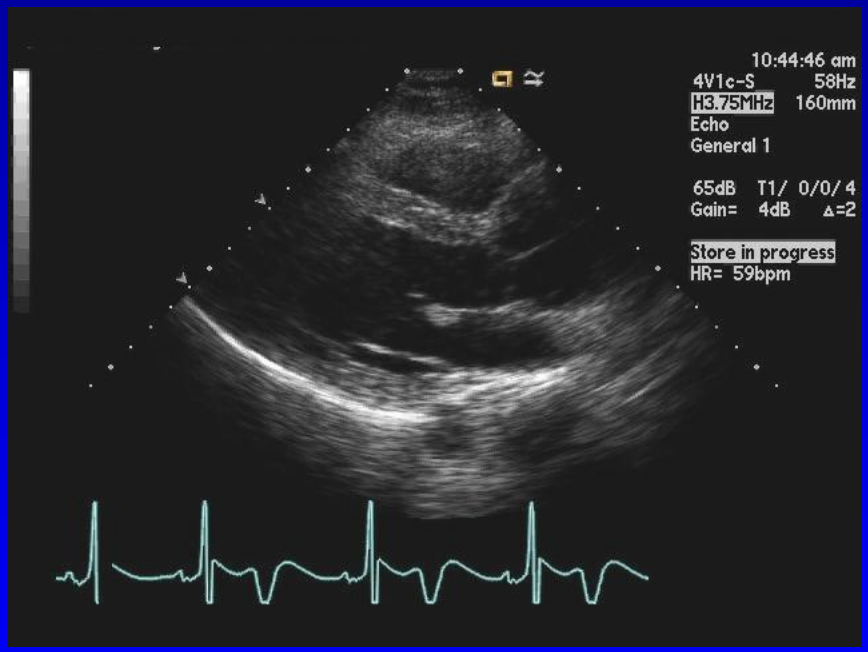
- Only “tall people” dissect
- Dissection is always preceded by significant dilation of the aorta
- The pain of dissection is classic and allows a precise diagnosis
- The physical exam and CXR will accurately screen for acute dissection
- Dissection most often results in fatal cardiac complications
- Surgery is much “better” now than in prior years
- Surgery always must be undertaken immediately

“Classic” vs. Common

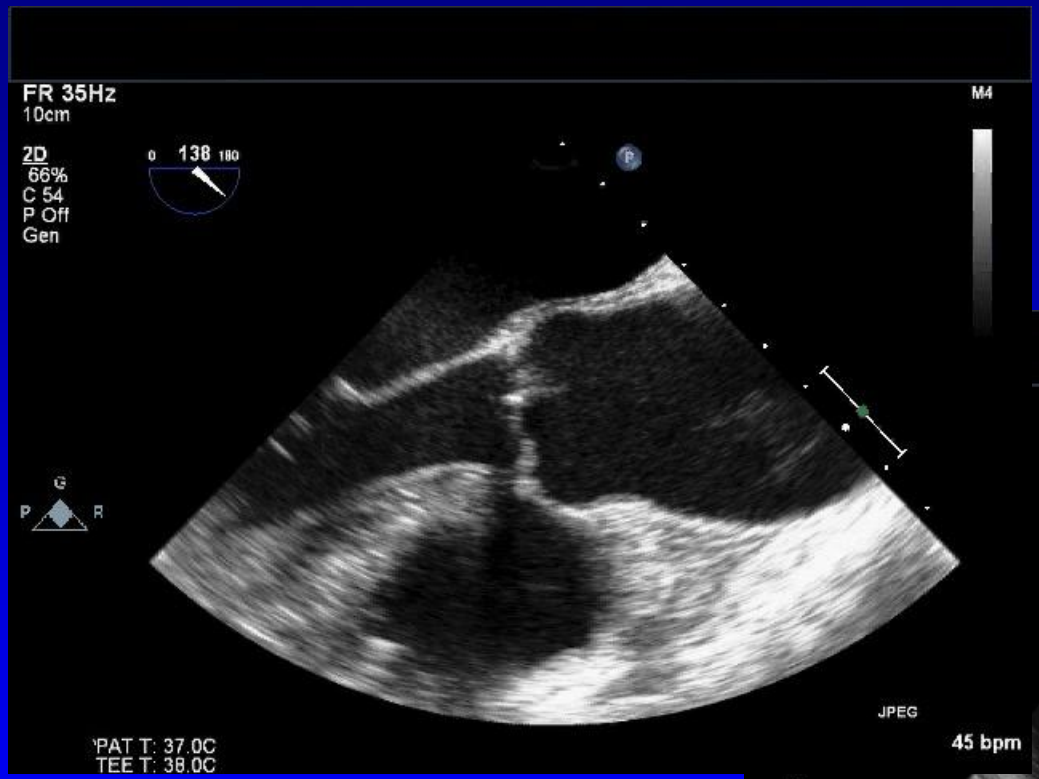
Flo Hyman 1954 - 1986

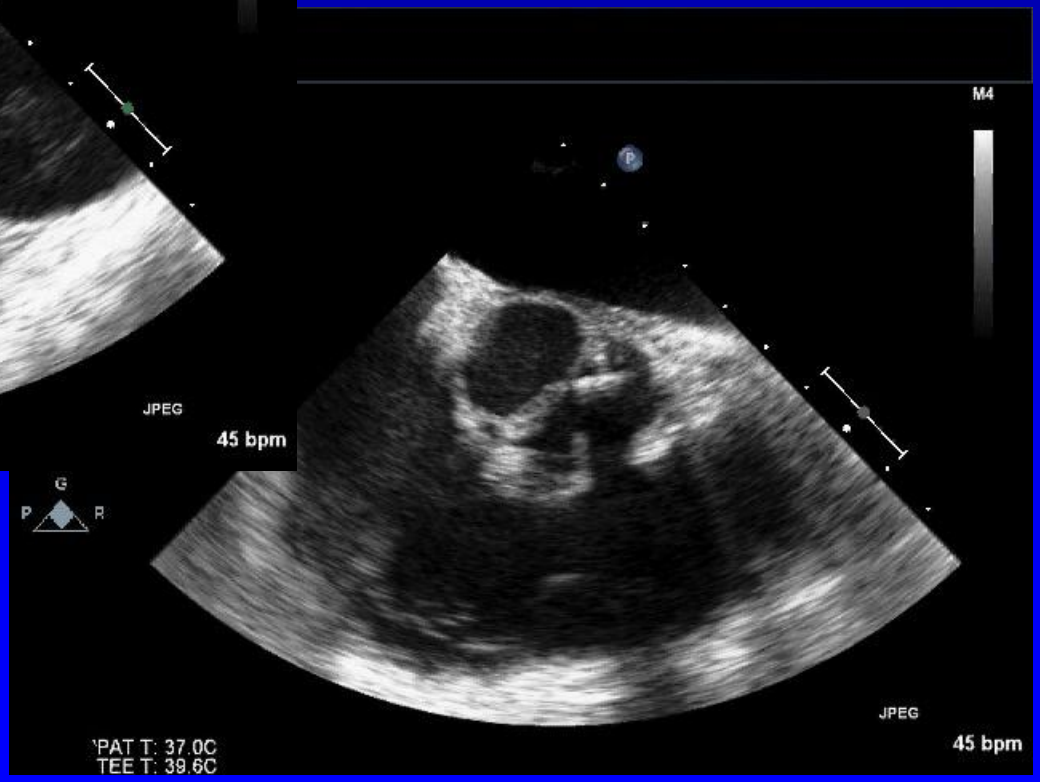
John Ritter

Marfan Syndrome



TEE of Bicuspid AV with Dilated Aorta





Aortic Dilation in Bicuspid Aortic Valve

Younger vs.. Older Patients with Acute Aortic Dissection - IRAD

Variables	Age <40 n = 68	Age ≥ 40 n = 883	p Value
Age, yrs (mean ± SD)	30.7 ±6.6	63.9 ± 11.5	NA
Type A	46 (68)	574 (65)	
Hypertension	23 (34)	635 (72)	< 0.001
Marfan Syndrome	34 (50)	19 (2)	< 0.001
Bicuspid aortic valve	6 (9)	12 (1)	< 0.001
Hypertension (SBP ≥ 150 mm Hg)	17 (25)	394 (45)	0.003

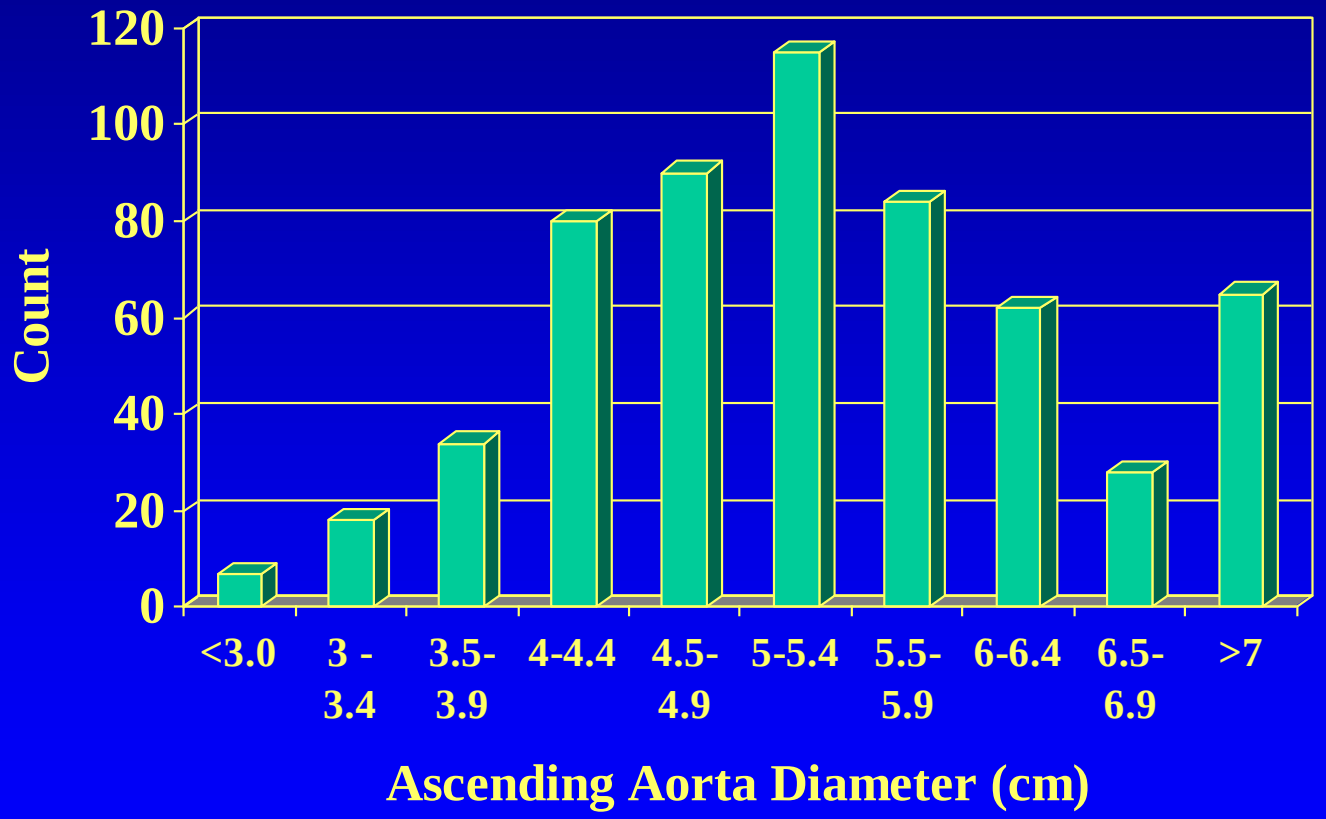
Januzzi et al JACC 2004

Aortic Diameter vs. Likelihood of Acute Dissection

- Aortic size on presentation with acute Type A dissection
- 591 patients
- Size from CT / TEE / MR or angiography
- HTN and age were associated with dissection at smaller size
- Marfan associated with larger size

Pape et al. IRAD, Circulation, 2007

Aortic Diameter vs. Likelihood of Acute Dissection



Pape et al. IRAD, Circulation, 2007

Clinical Presentation: Pain Character

Pain	A + B	Type A	Type B	p=
Any pain	95.5%	93.8%	98.3%	.02
Abrupt	**84.8%**	**85.4%**	**83.8%**	**.65**
Chest	72.7%	78.9%	62.9%	<.001
Anterior	60.9%	71%	44%	<.001
Back	53.2%	46.6%	63.8%	<.001
Abdominal	29.6%	21.6%	42.7%	<.001

Hagan et al. JAMA 2000

Clinical Presentation: Pain Character

Pain	A + B	Type A	Type B	p=
10 of 10	**90%**	**90%**	**90%**	
Sharp	64%	62%	68%	
Tearing	51%	49%	52%	
Migrating	17%	13%	19%	.22
Radiating	28%	27%	30%	.51
Syncope	9%	13%	4%	.002

Hagan et al. JAMA 2000

The Pain of Dissection: Practical Clues

- Classic, abrupt, tearing chest & back pain does occur – but it represents a minority of cases
- Other clues:
  - Pain with multiple migratory areas
  - Recurrent pain - stable EKG
  - Pain not responsive to NTG
  - Minimal troponin leak
  - **Abrupt onset, no prodrome**

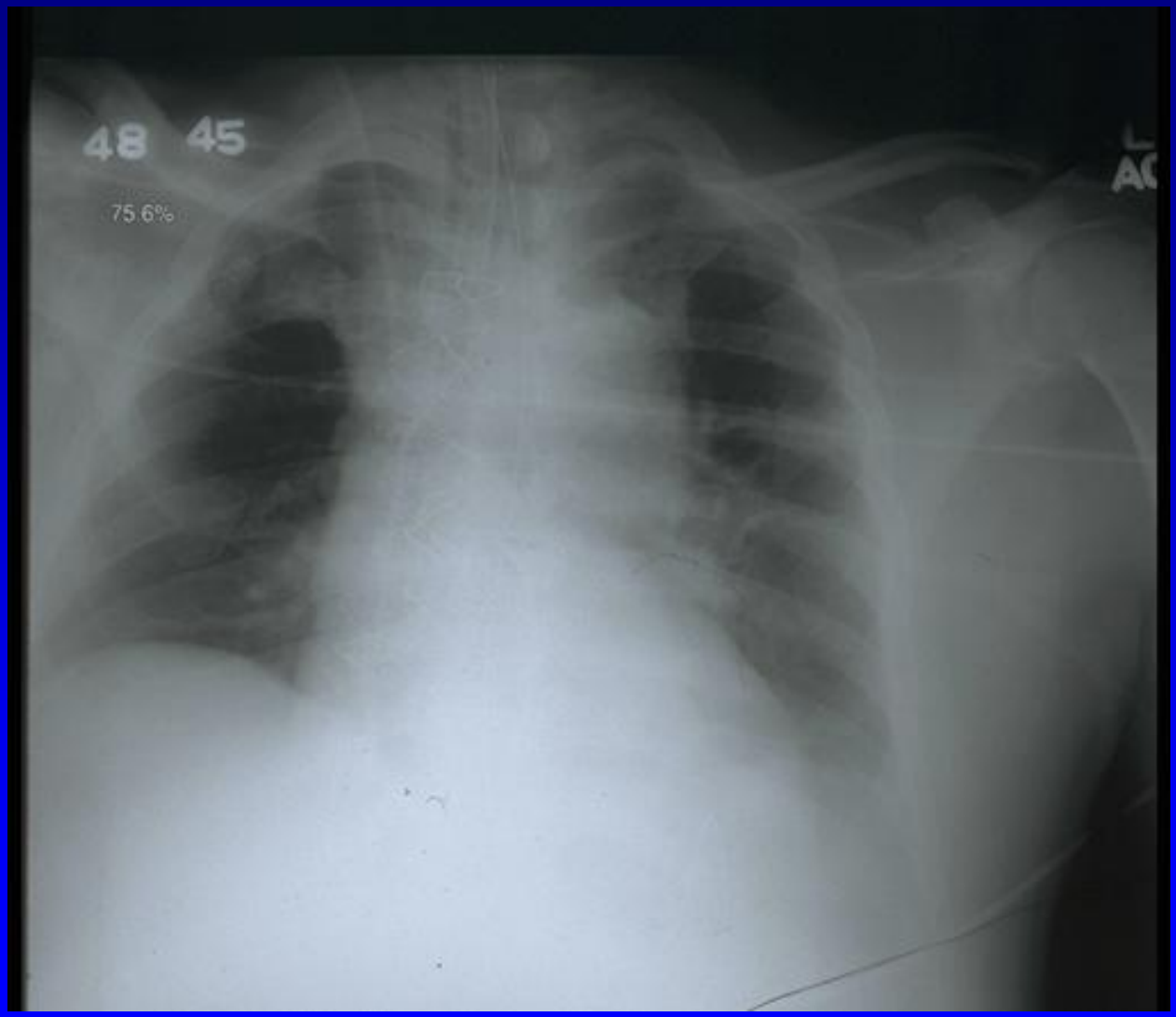
Clinical Presentation: Physical Exam

	A + B	Type A	Type B	p=
AI on exam	32%	44%	12%	<.001
Pulse			%	.006
CVA			%	.07
CHF			%	.02

On echocardiography > 70% of patients will have aortic insufficiency

Hagan et al. JAMA 2000

Case #8 CXR



Clinical Presentation: CXR

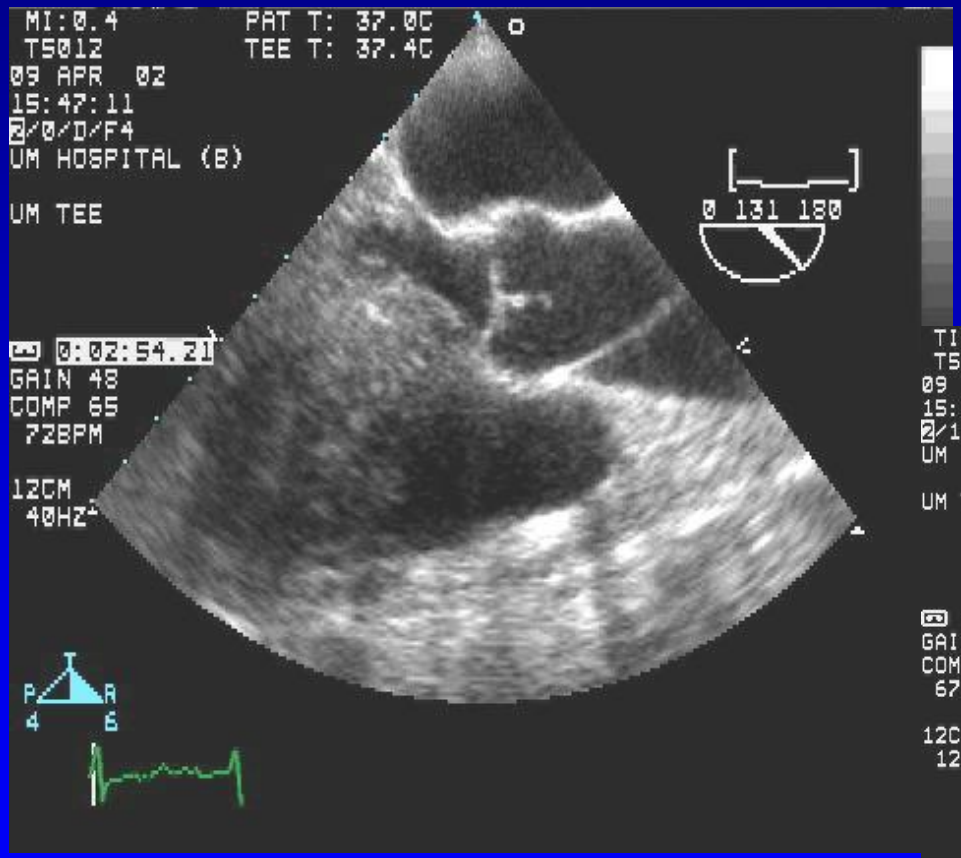
N= 427	A + B	A	B	p=
No Abnormality	12%	11%	16%	.08
Mediastinum Nl	21%	17%	27%	.01
Wide Mediastinum	62%	63%	56%	.17
Aorta Abnormal	50%	47%	53%	.20
Heart Abnormal	26%	27%	24%	.49
Pleural Effusion	19%	17%	22%	.24

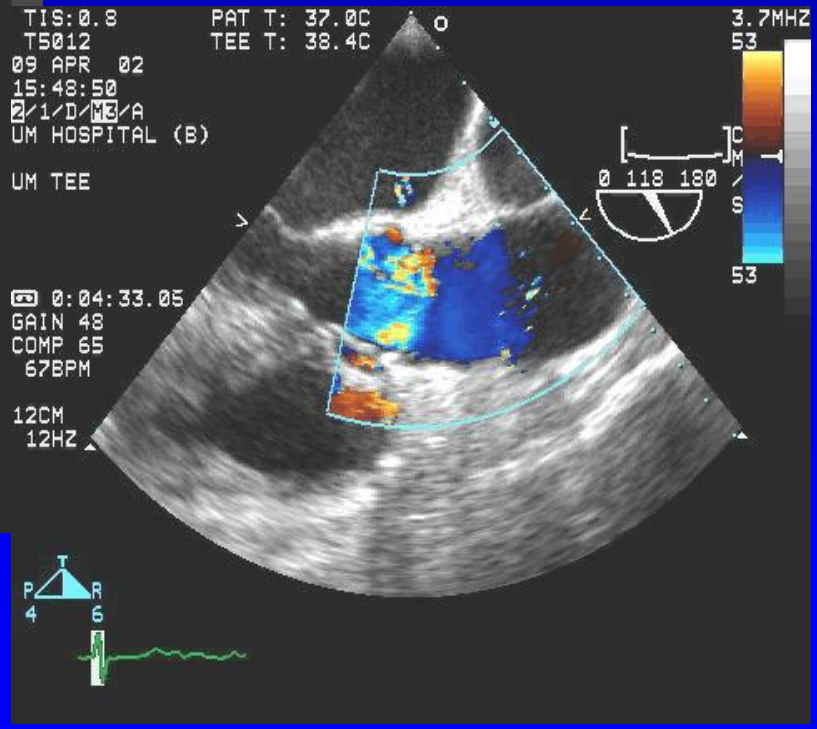
Hagan et al. JAMA 2000

When to Order Which Test?

- Order the test which works best in your hands and establishes / excludes the diagnosis the fastest and most reliably
- Generally this will be CTA or TEE
- Liberally order a second test if #1 is inconclusive or specific data are missing
- Over 75% of patients in IRAD centers undergo two or more imaging studies

56 YO Male with Chest Pain





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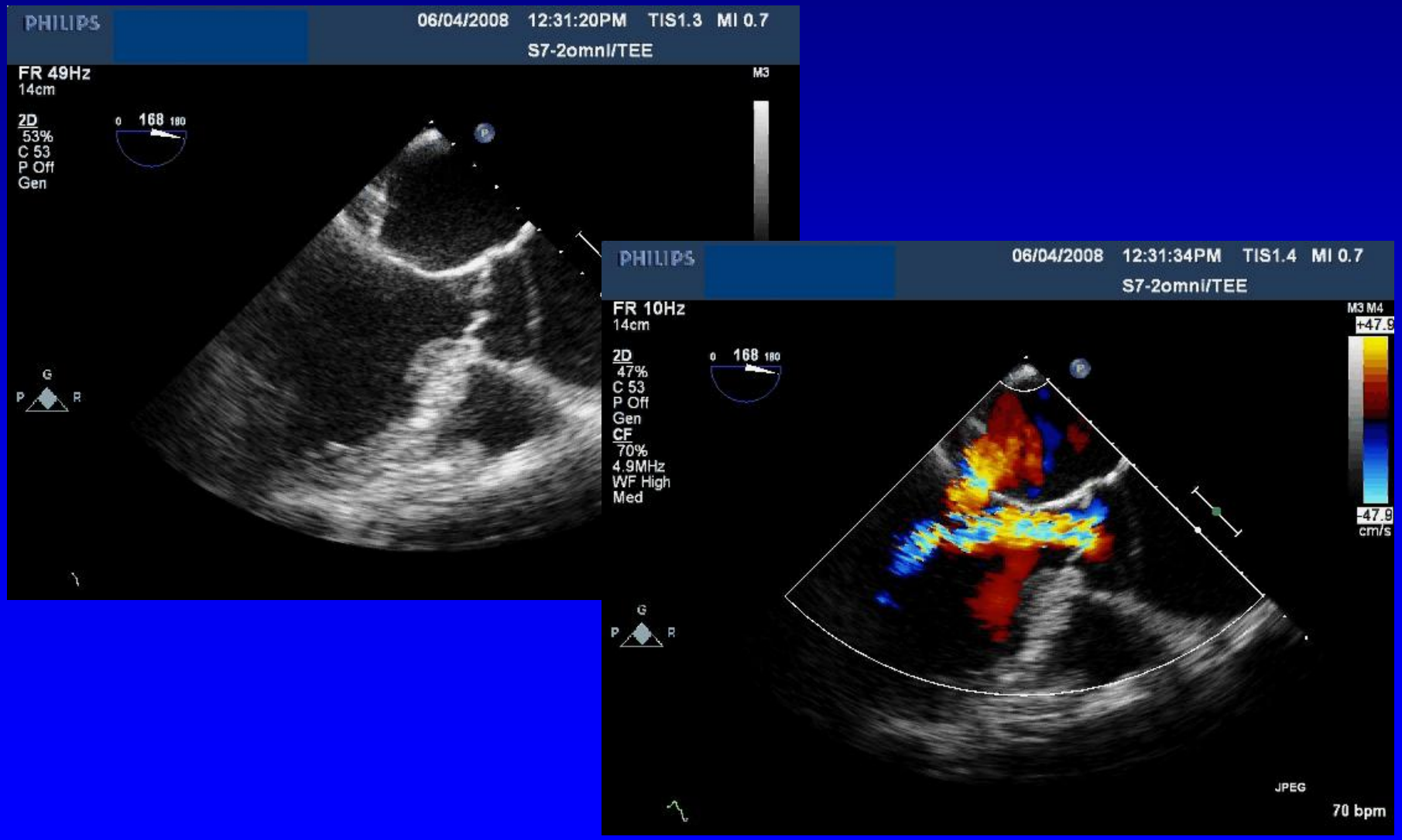
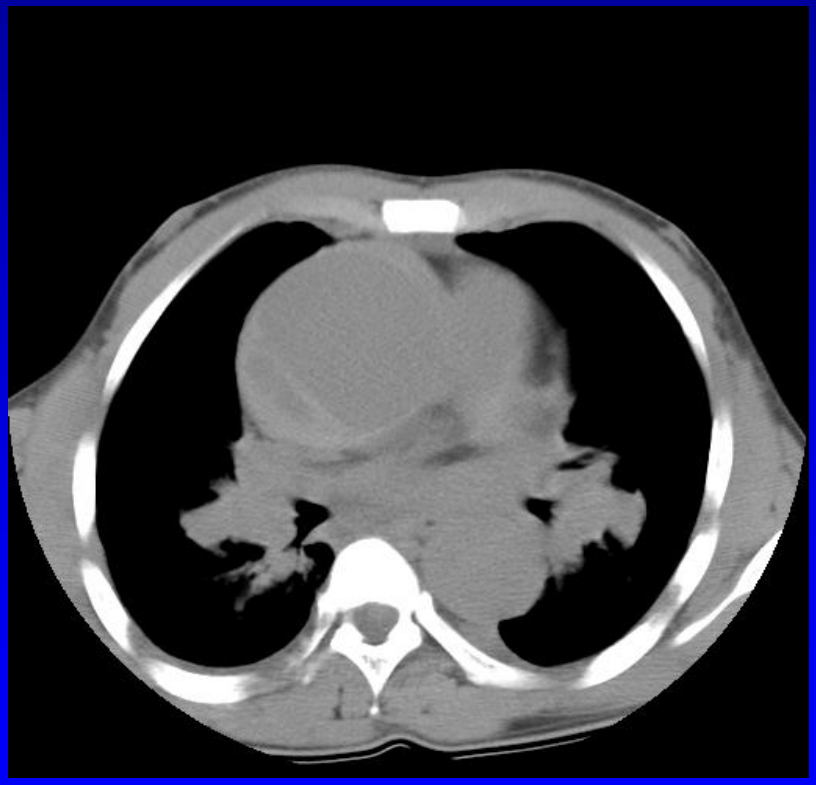
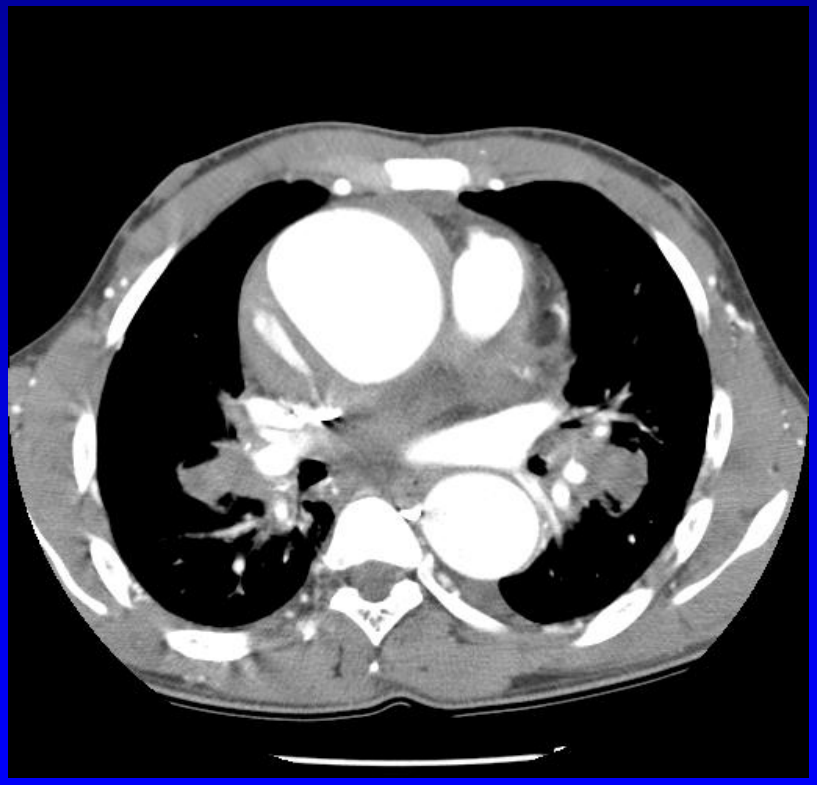
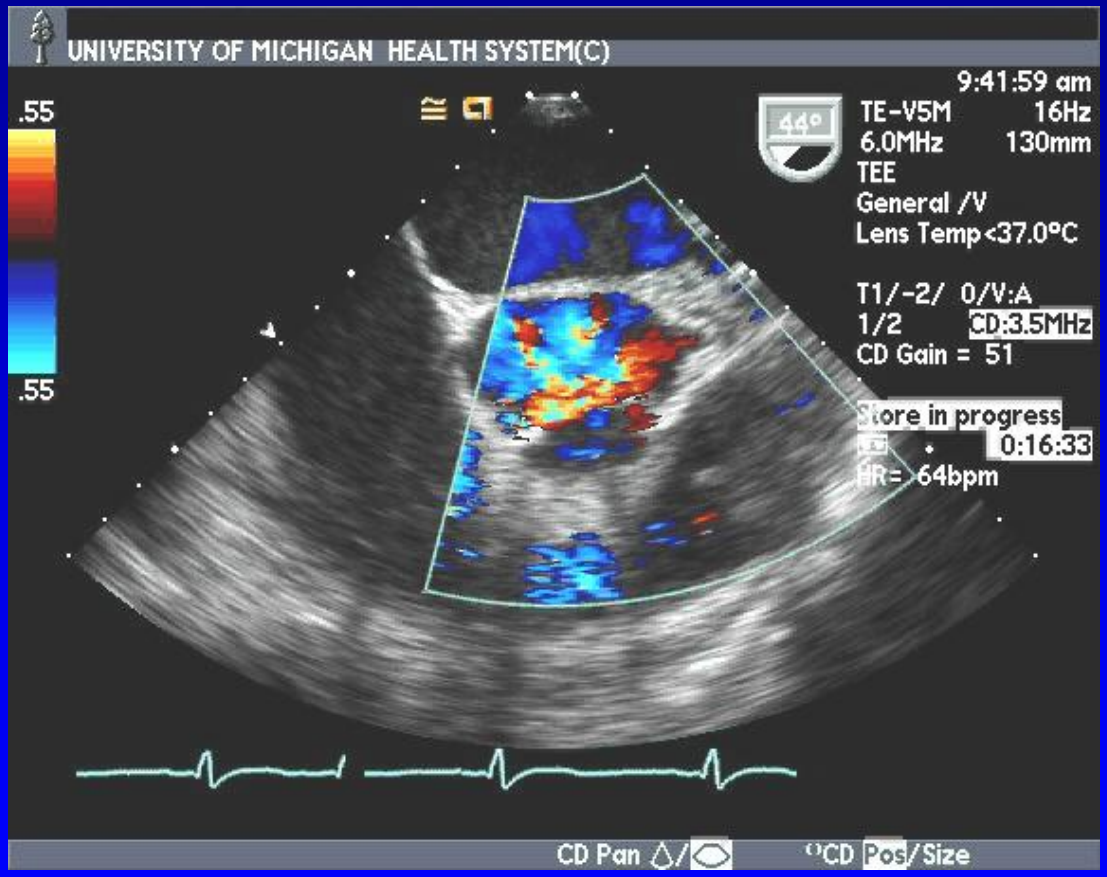


Acute Type A Dissection

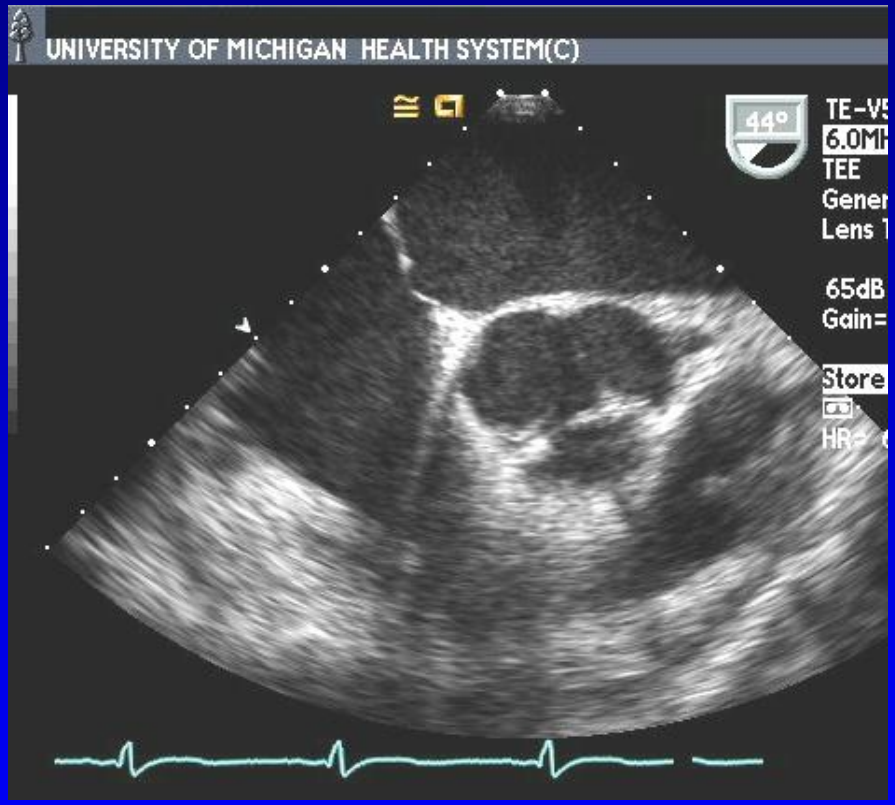


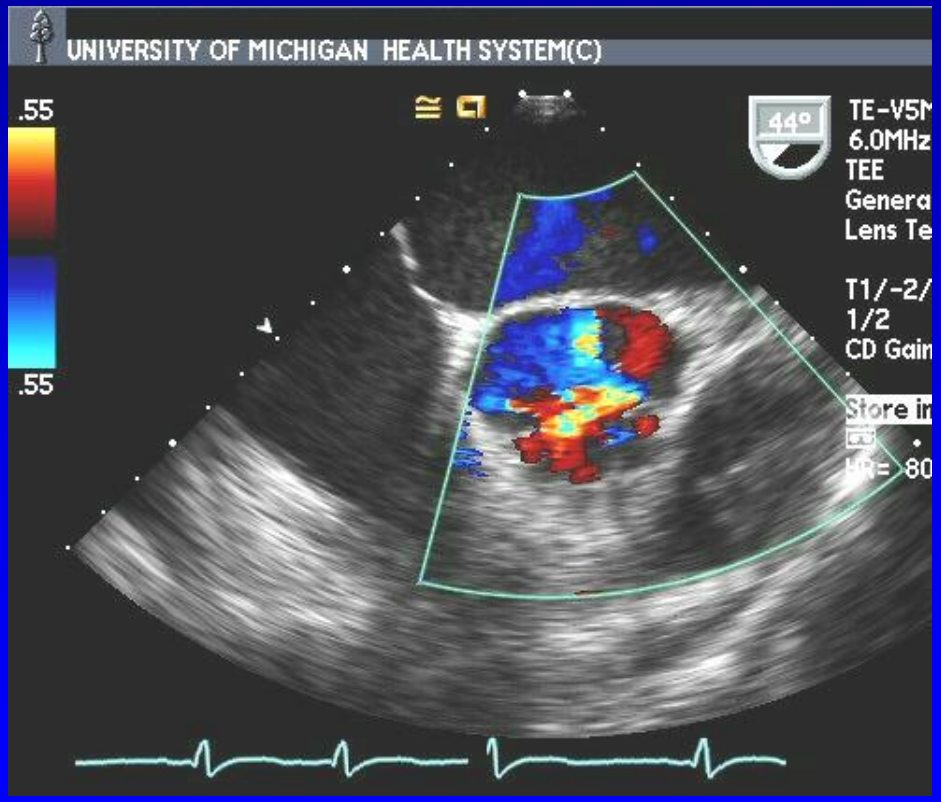


Type A with AI



Mechanism of AI in Type A Dissection





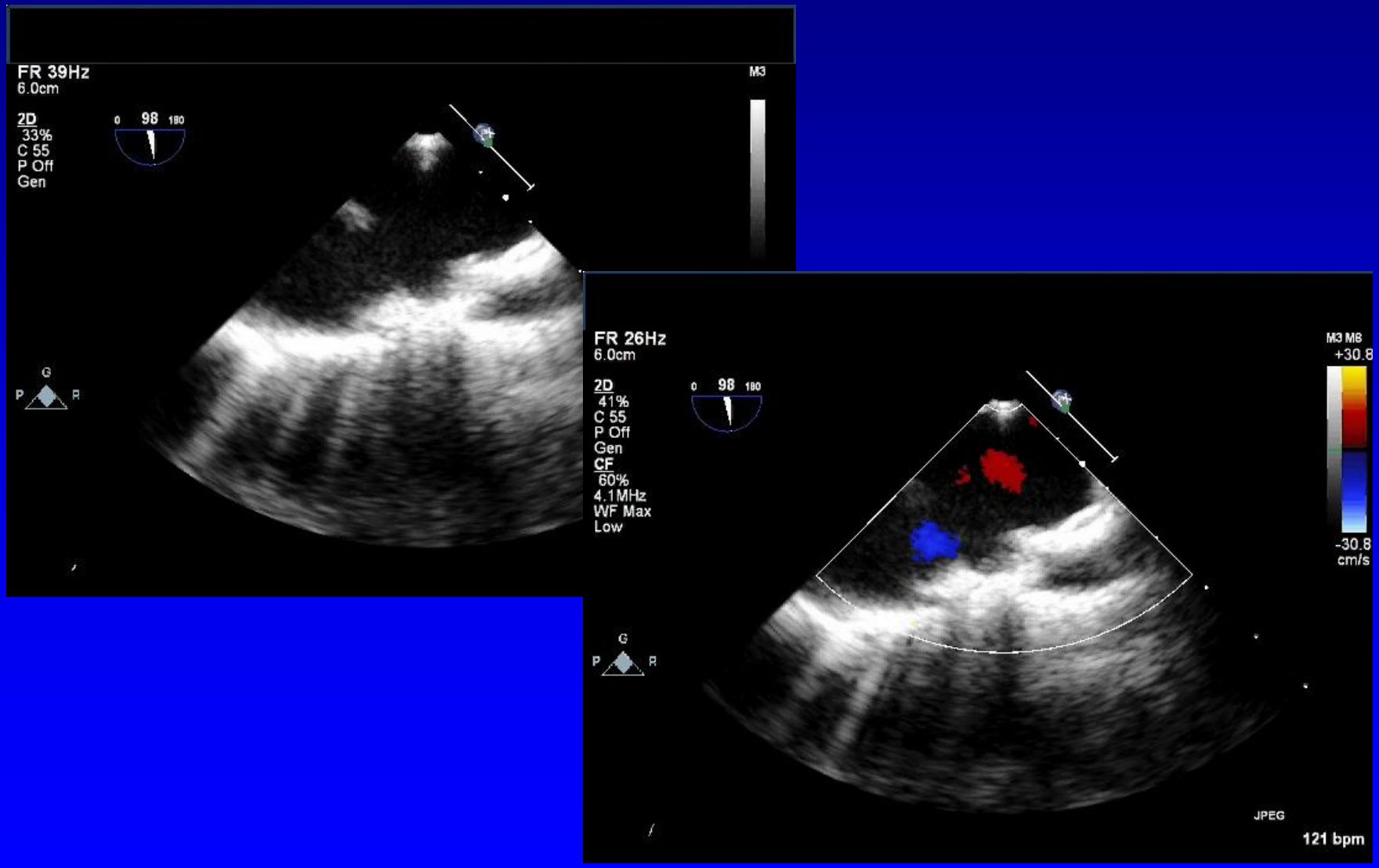
Accuracy of Transesophageal Echocardiography for Detection of Aortic Dissection

Ref.	*N*	*Sensitivity*	*Specificity*	*Probe*
Erbel et al., 1987	**21**	**21/21 (100%)**	**N/C**	**SP**
Erbel et al., 1989	**164**	**81/82 (98.7)**	**78/80 (97.5%)**	**SP**
Hashimoto et al., 1989	**22**	**22/22 (100%)**	**N/C**	**BP**
Adachi et al., 1991	**45**	**44/45 (97.7%)**	**N/C**	**SP. BP**
Ballal et al., 1991	**61**	**33/34 (97%)**	**27/27 (100%)**	**SP, BP**
Simon et al., 1992	**32**	**28/28 (100%)**	**4/4 (100%)**	**SP, BP**
Nienaber et al., 1993	**70**	**43/44 (97.7%)**	**20/26 (76.9%)**	**BP**
Karen et al., 1996	**112**	**48/49 (98%)**	**60/63 (95%)**	**BP, MP**
Total	**527**	**320/325 (98.5%)**	**189/200 (94.5%)**	

Limitations of Transesophageal Echocardiography

- No visualization below the diaphragm
- Inexperienced operator
- Inexperienced operator
- Inexperienced operator
- Limited IMH
- Isolated arch pathology

Discrete Arch Aneurysm



Discrete Arch Aneurysm

Causes of Mortality in Acute Aortic Dissection

- Cardiovascular
  - Tamponade
  - Aortic rupture
  - Coronary compromise
- Major organ compromise
  - Mesenteric
  - Renal
  - CNS
- Surgical and post surgical

Generally Early

All equally fatal.

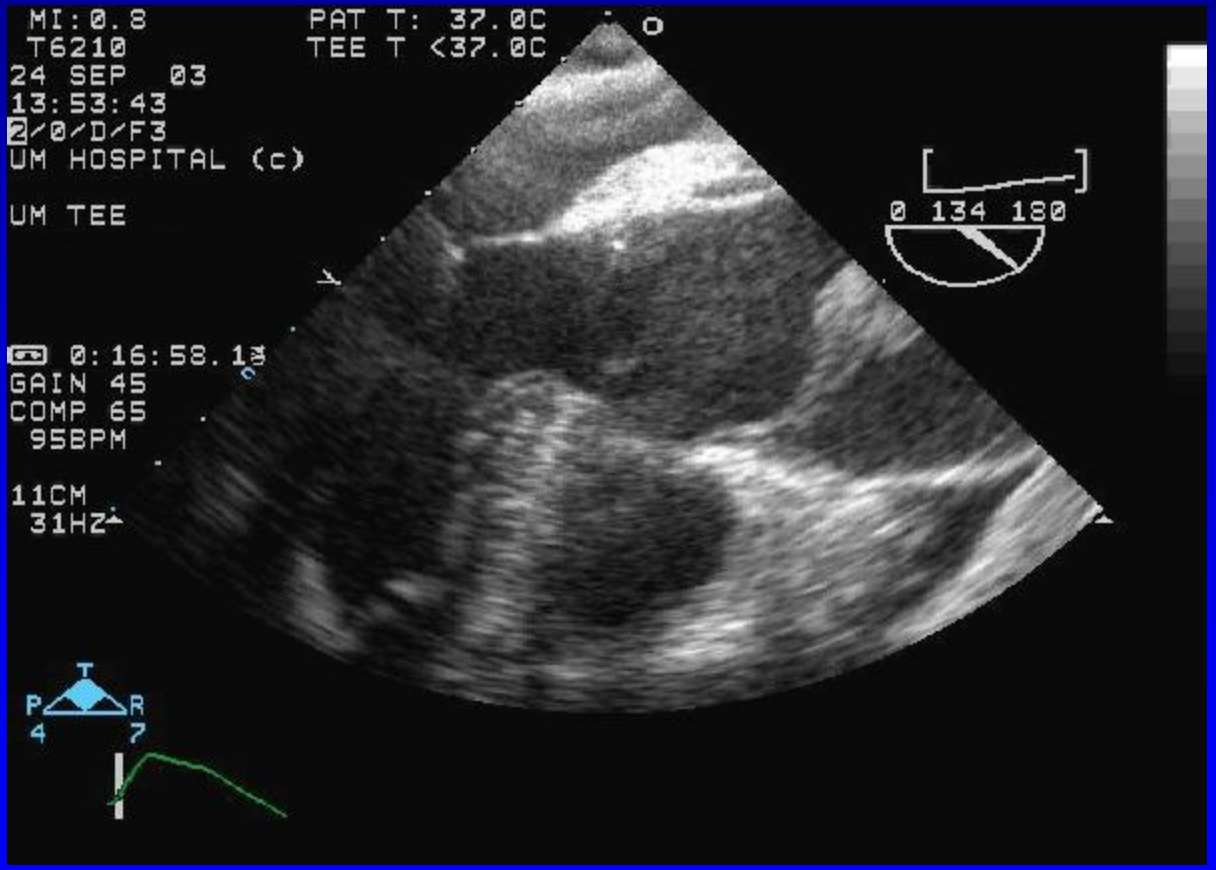
Generally Delayed

Type A Dissection: Hospital Mortality

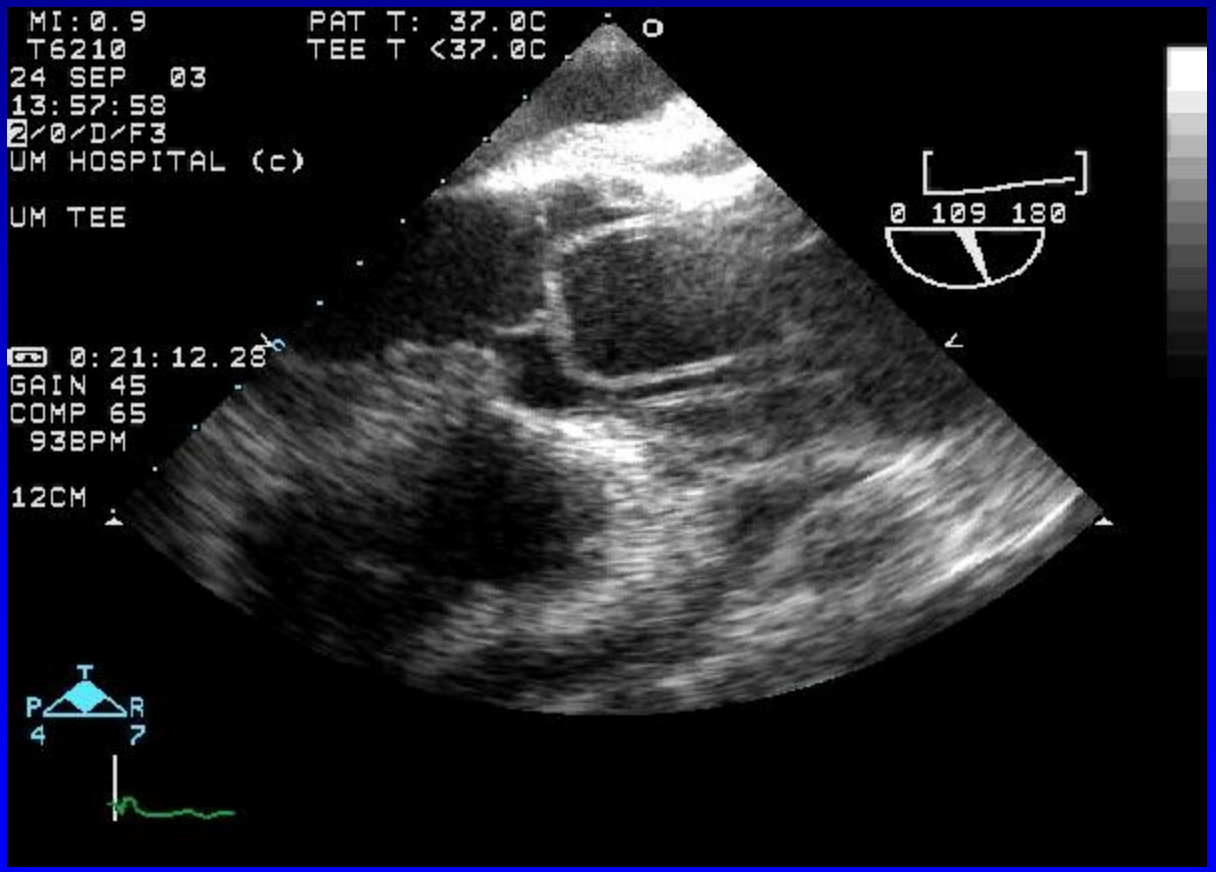
- Acute Type A dissection
  - n= 547
  - age 62 ± 14 years
  - 32.5% Hospital mortality
- Demographics and clinical presentation for markers of adverse outcome
- Predictive model developed

R Mehta for the IRAD Investigators, Circulation 2002

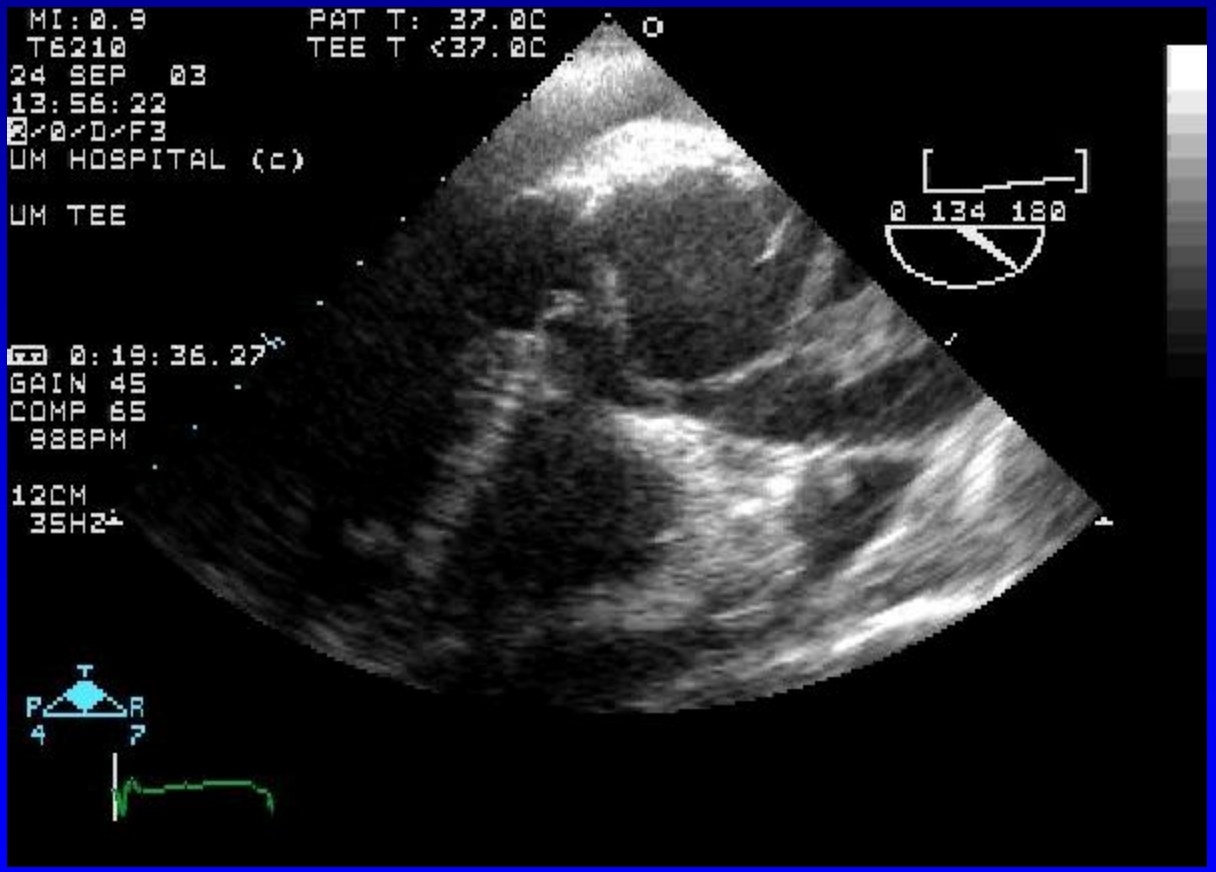
63 YO Male with Syncope



63 YO Male with Syncope: Two Minutes Later



63 YO Male with Syncope: Three Minutes Later

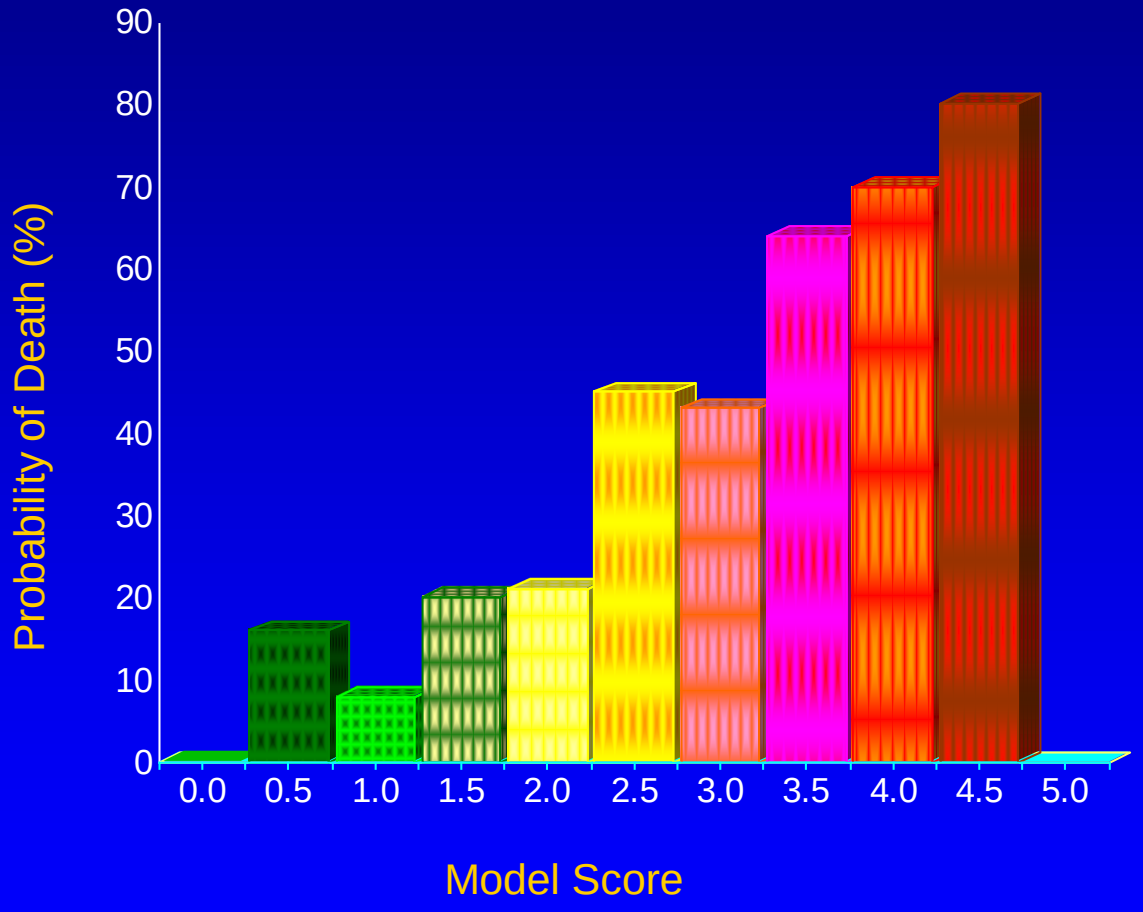


Type A Dissection Predictive Model

Variable	**Score**	O.R.	P=
Age > 70 years	**0.5**	1.7	0.03
Female	**0.3**	1.4	0.2
Abrupt pain	**1.0**	2.6	0.01
Abnormal ECG	**0.6**	1.8	0.03
Pulse deficit	**0.7**	2.0	0.004
Renal failure	**1.6**	4.8	0.002
Hypotension / shock	**1.1**	3.0	<0.0001

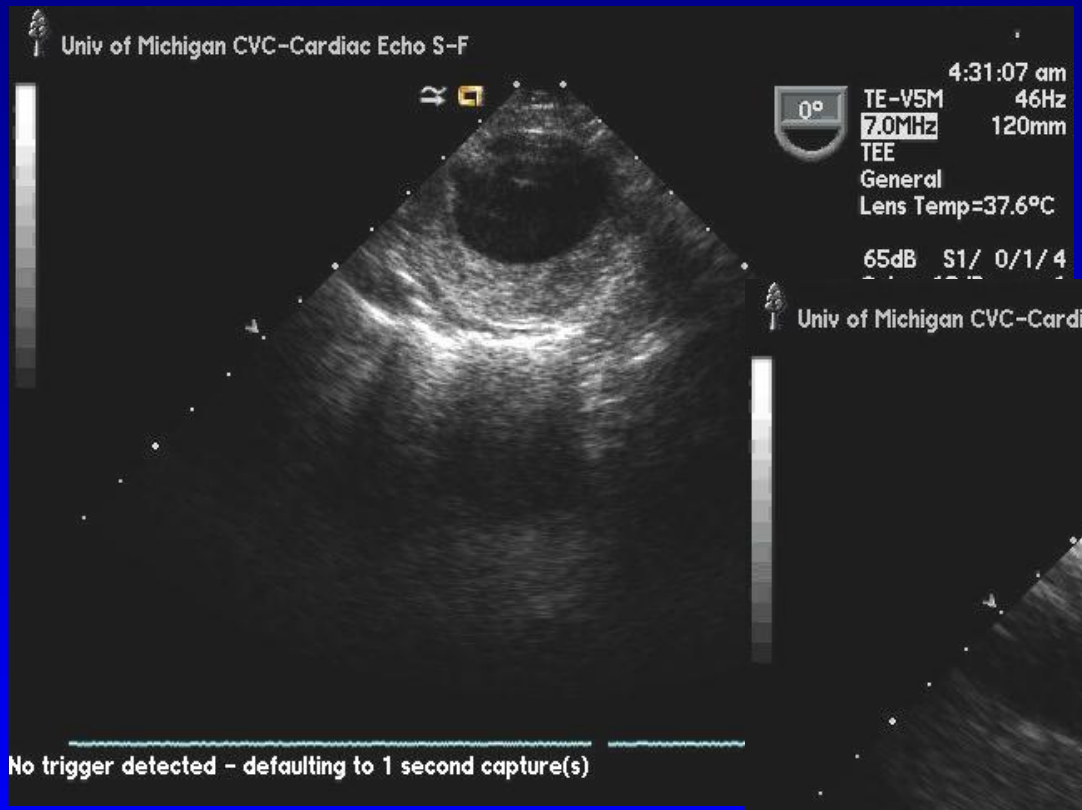
R Mehta for the IRAD Investigators, Circulation 2002

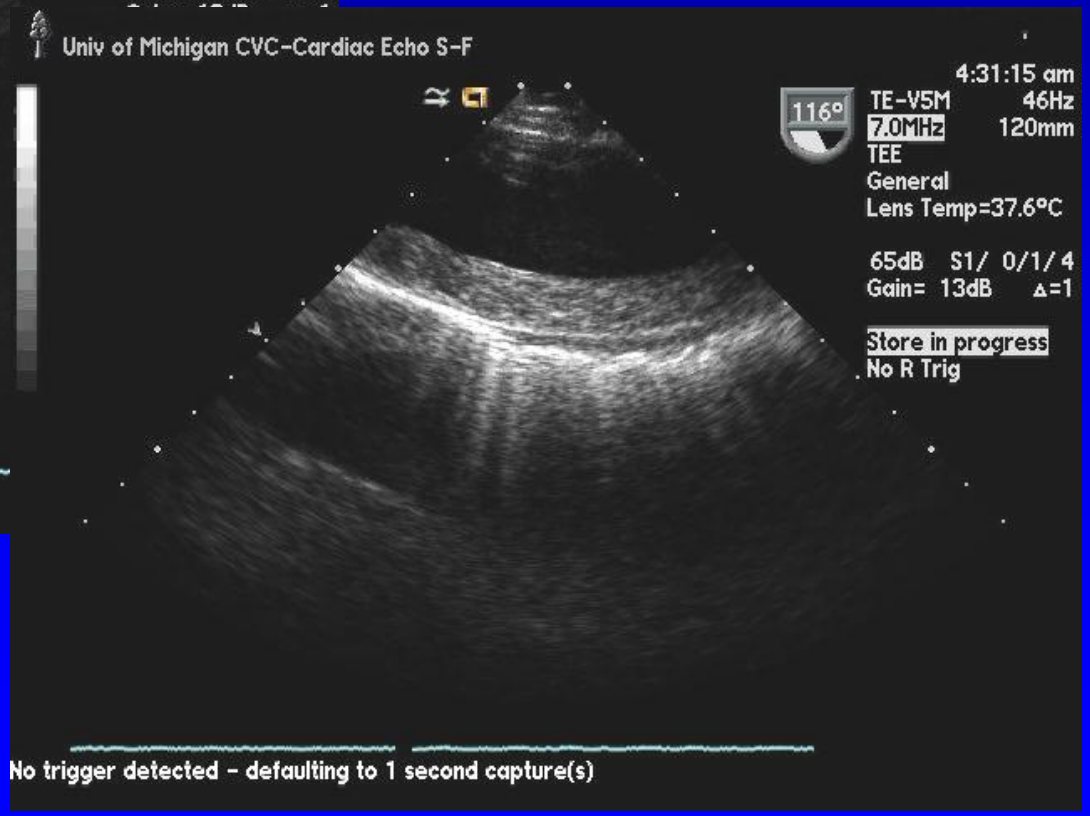
Mortality With Acute Type A Aortic Dissection: vs. Predictive Score



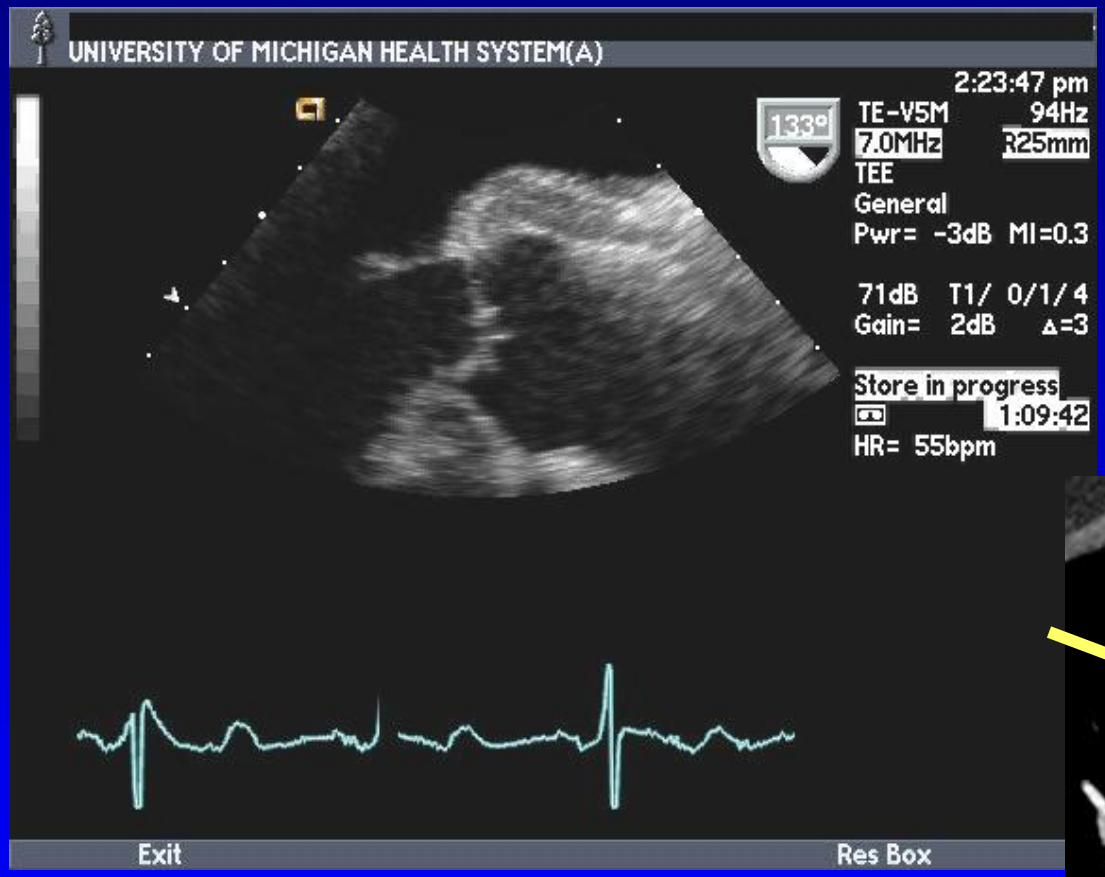
Mehta et al. circulation 2002

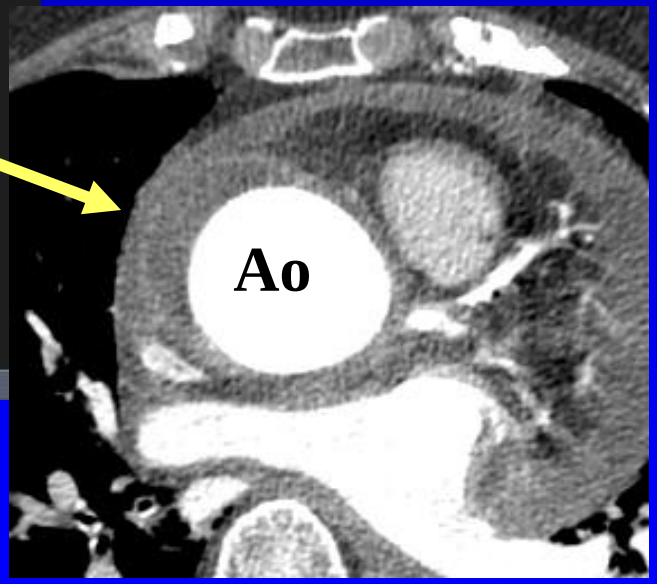
Intramural Hematoma



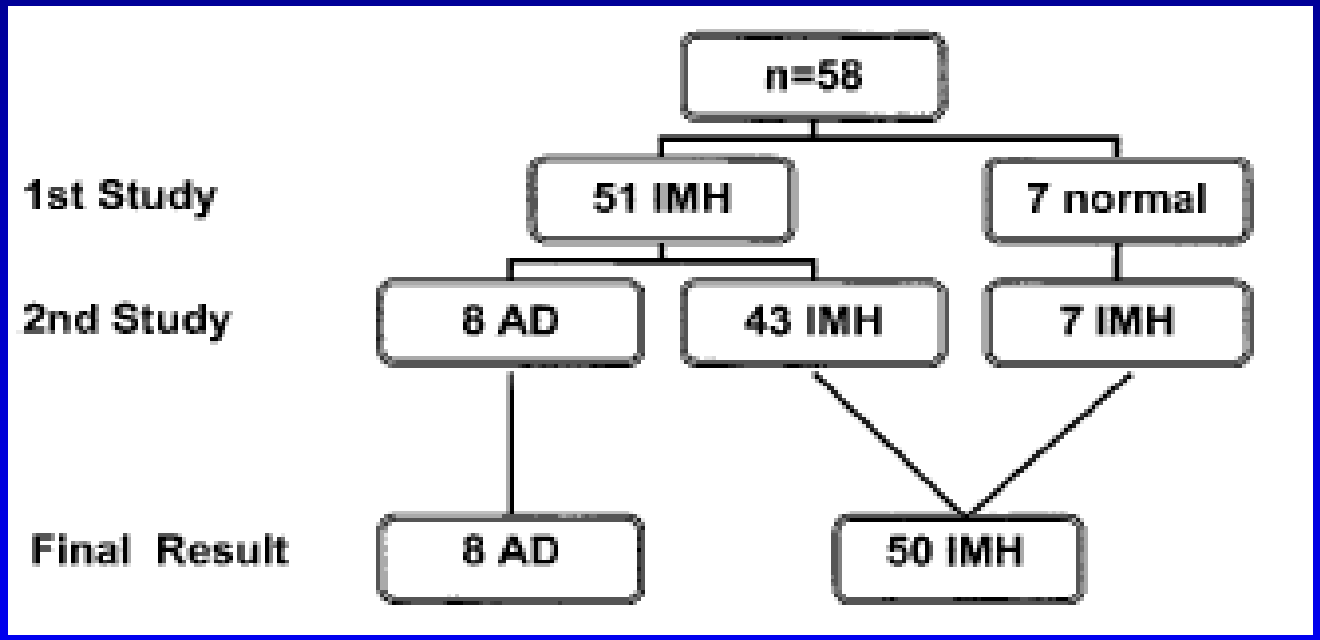


Intramural Hematoma



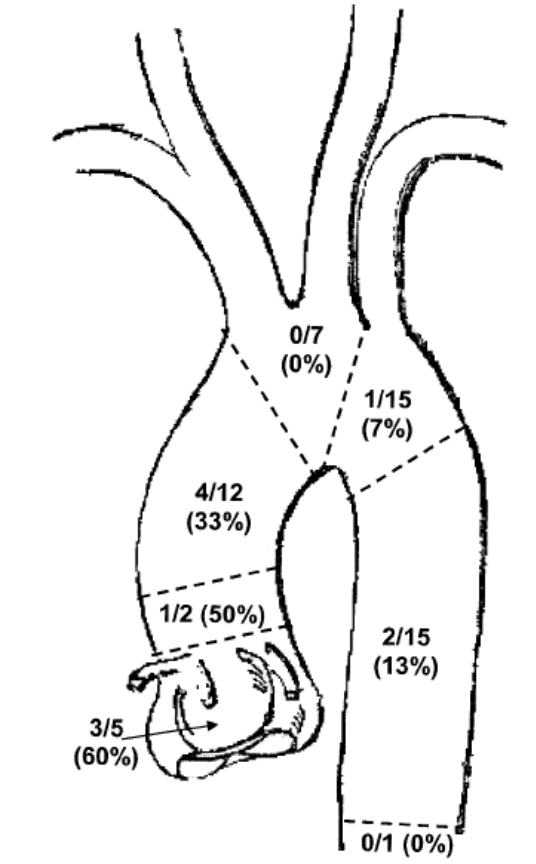


Evolution in Diagnosis of IMH



Evangelista A, et al., Circulation 2005;111:1063-1070

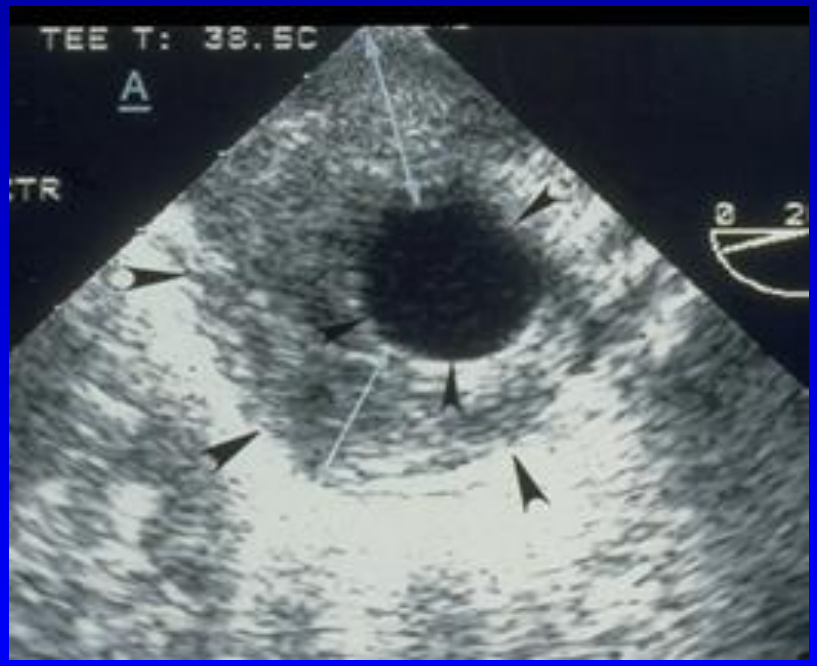
In-hospital Mortality for IMH



- 1010 patients with AAD in IRAD
- IMH in 58 (5.7%)
- Less likely to have AI or pulse deficits
- More difficult to diagnose
- Less often surgically treated

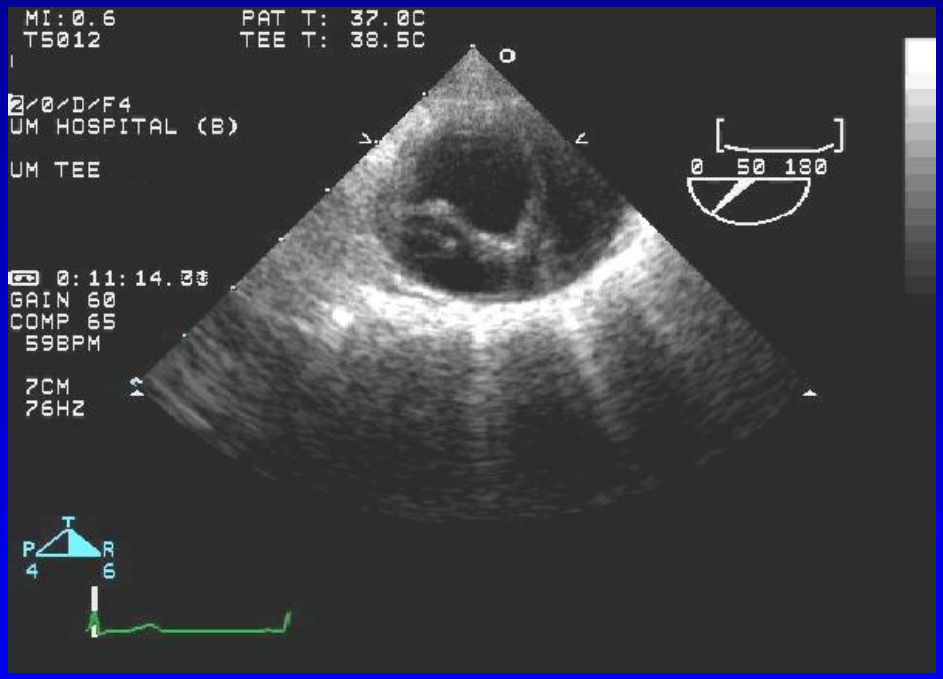
Evangelista A, et al., Circulation 2005;111:1063-1070

Adventitial Hematoma



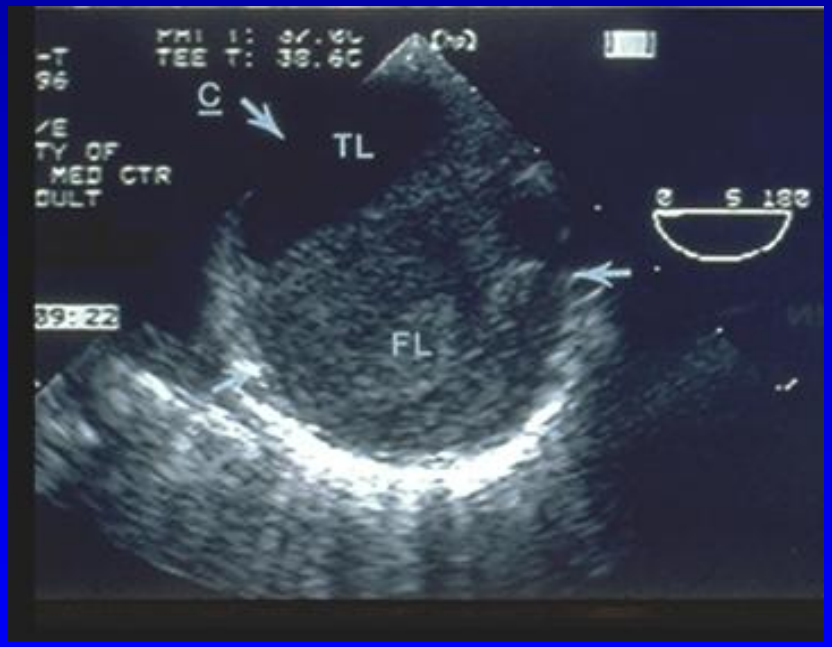
- Represents leak of blood outside the aortic lumen
- Implies partial rupture at some location along the dissection
- Potentially unstable hemodynamics
- Independent predictor of mortality in surgical patients

TEE: Patent False Lumen



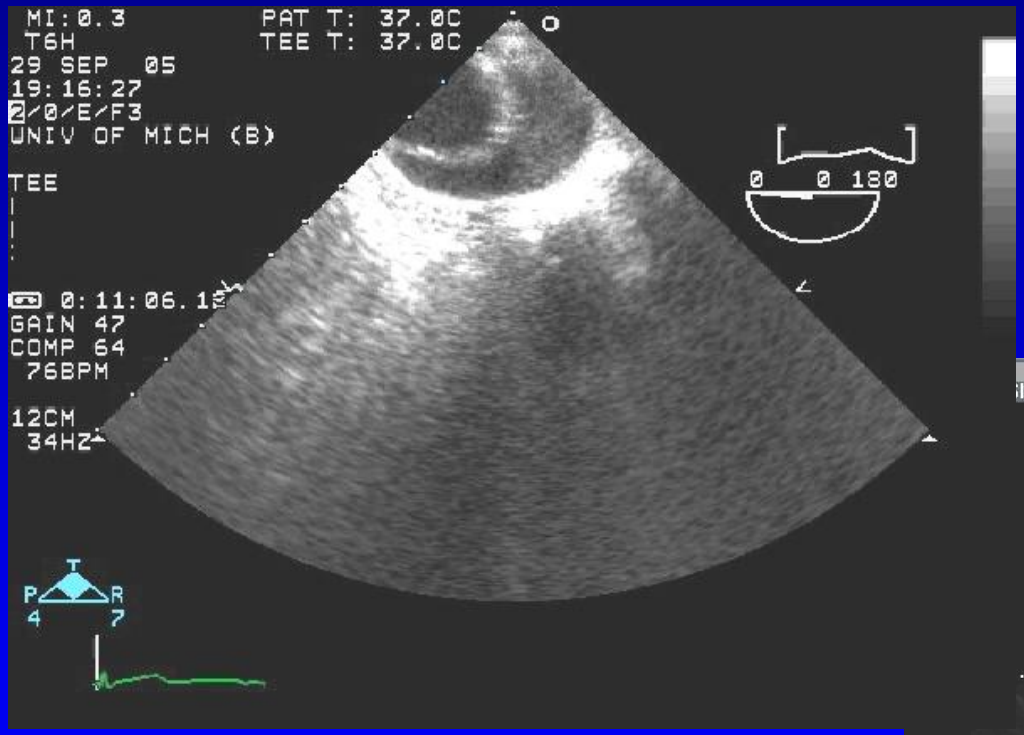
- Acutely allows further propagation of dissection (type A)
- Subsequent additional organ compromise
- Chronically in type B appears protective

False Lumen Thrombosis



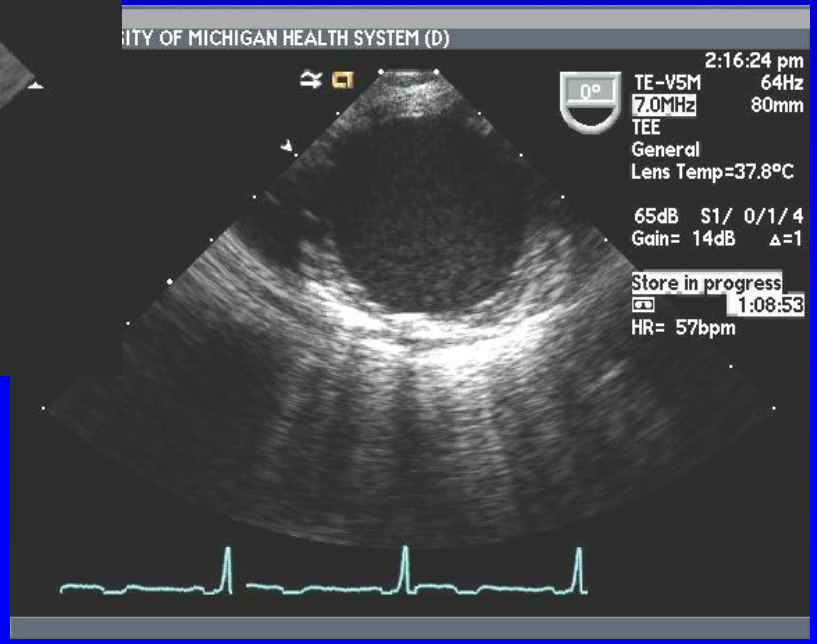
- Implies a completed event
- No hydrodynamic drive for further propagation
- Presumed stable wall structure

“Healed Type B Dissection



At presentation

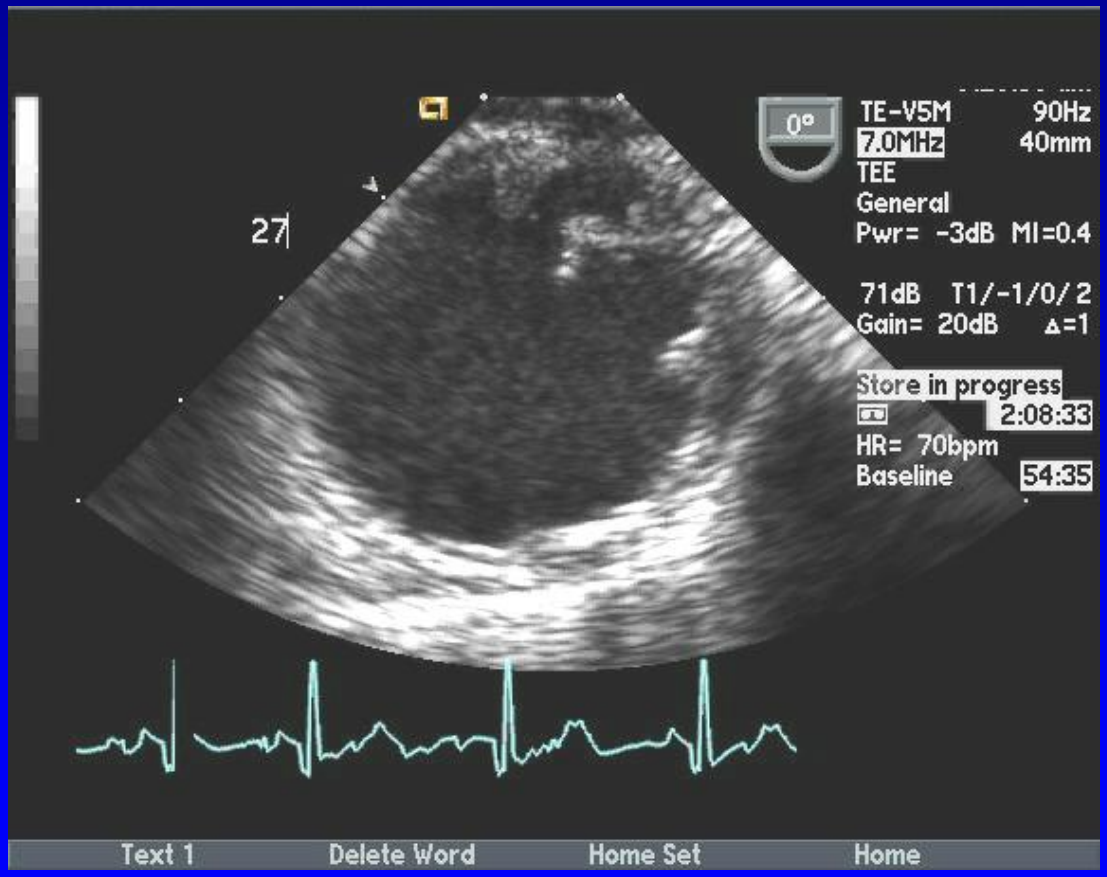
Three months later



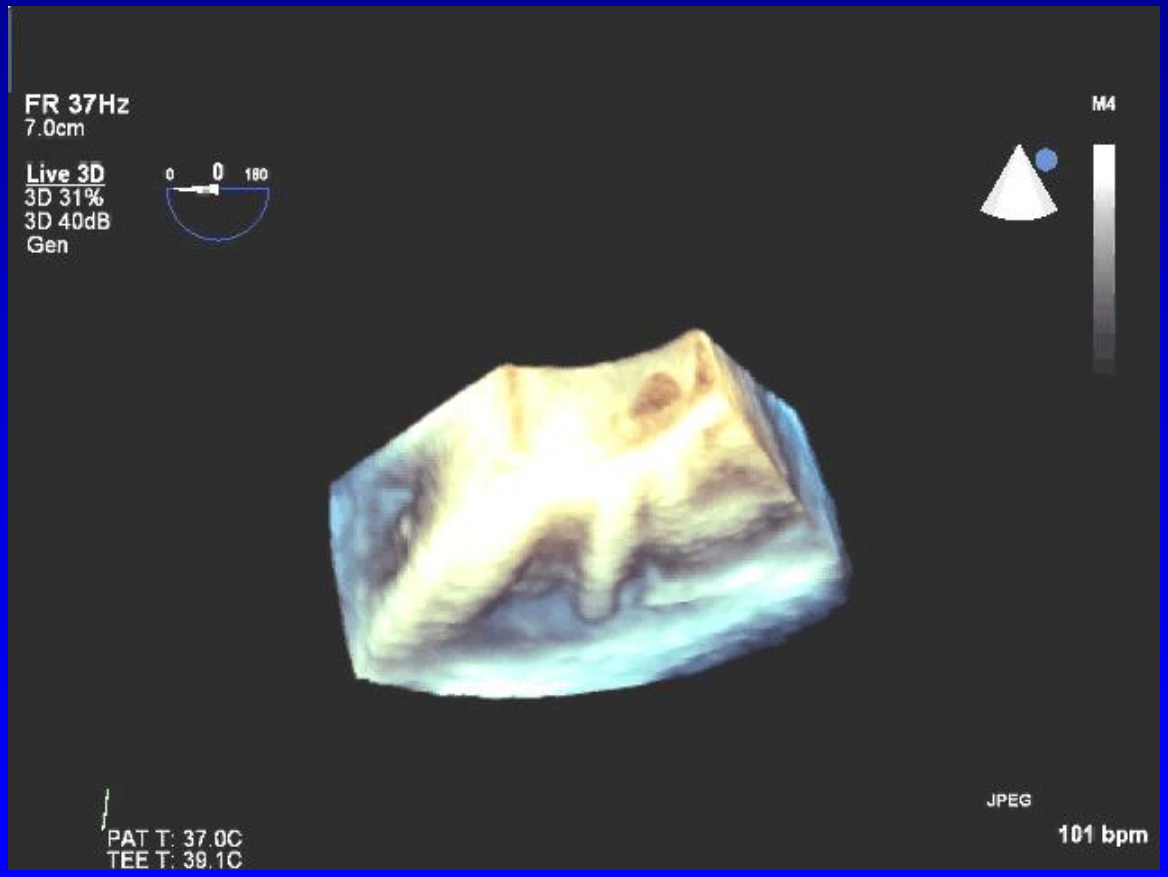
Ulcerated Plaque

- Symptoms of an acute aortic syndrome
- Virtually always have severe atheromatous disease, usually in descending thoracic aorta
- Penetrates to variable degree and may extend through aortic wall
- Treatment based on “anatomic insult”
  - Medical vs. Surgical. vs. Percutaneous

Ulcerated Plaque



Ulcerated Plaque



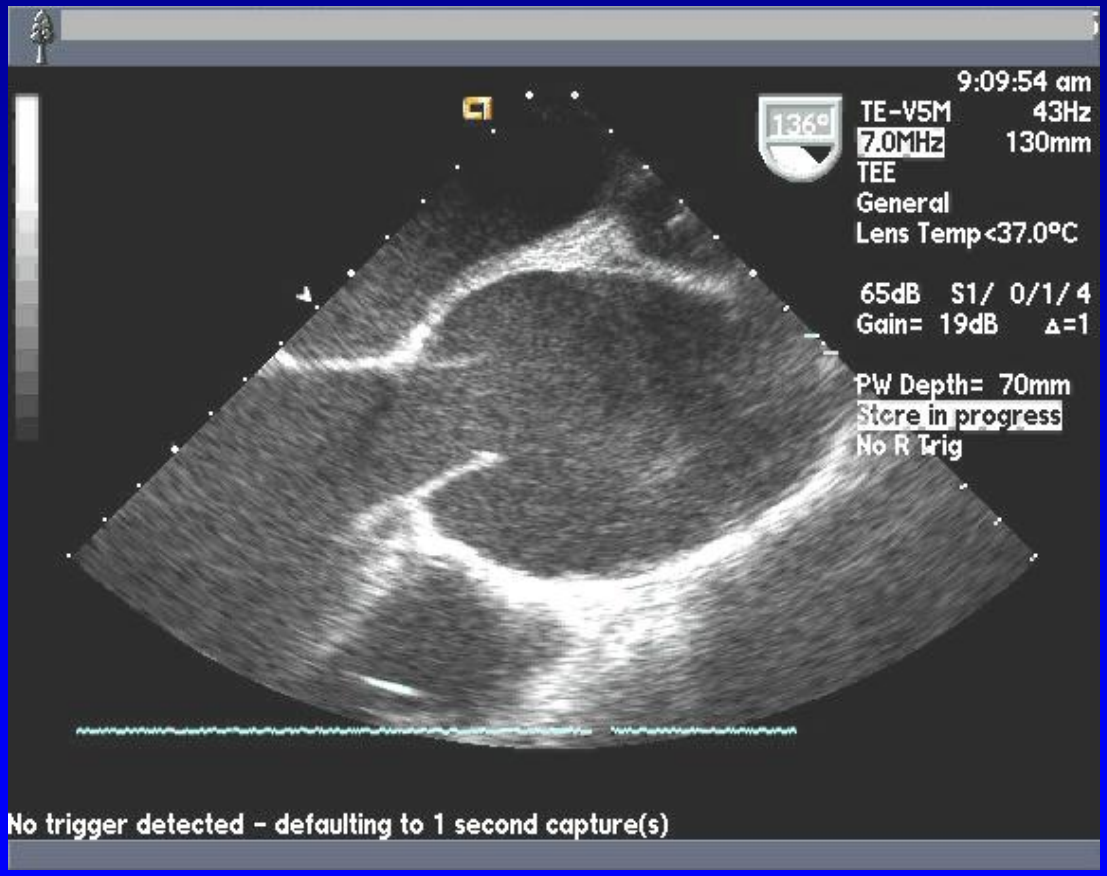
Ulcerated Plaque or Natural History Museum Diaorama?

2009: Where are We with Surgery for Acute Aortic Dissection?

There's good news,
and there's
bad news.

First the good news!!

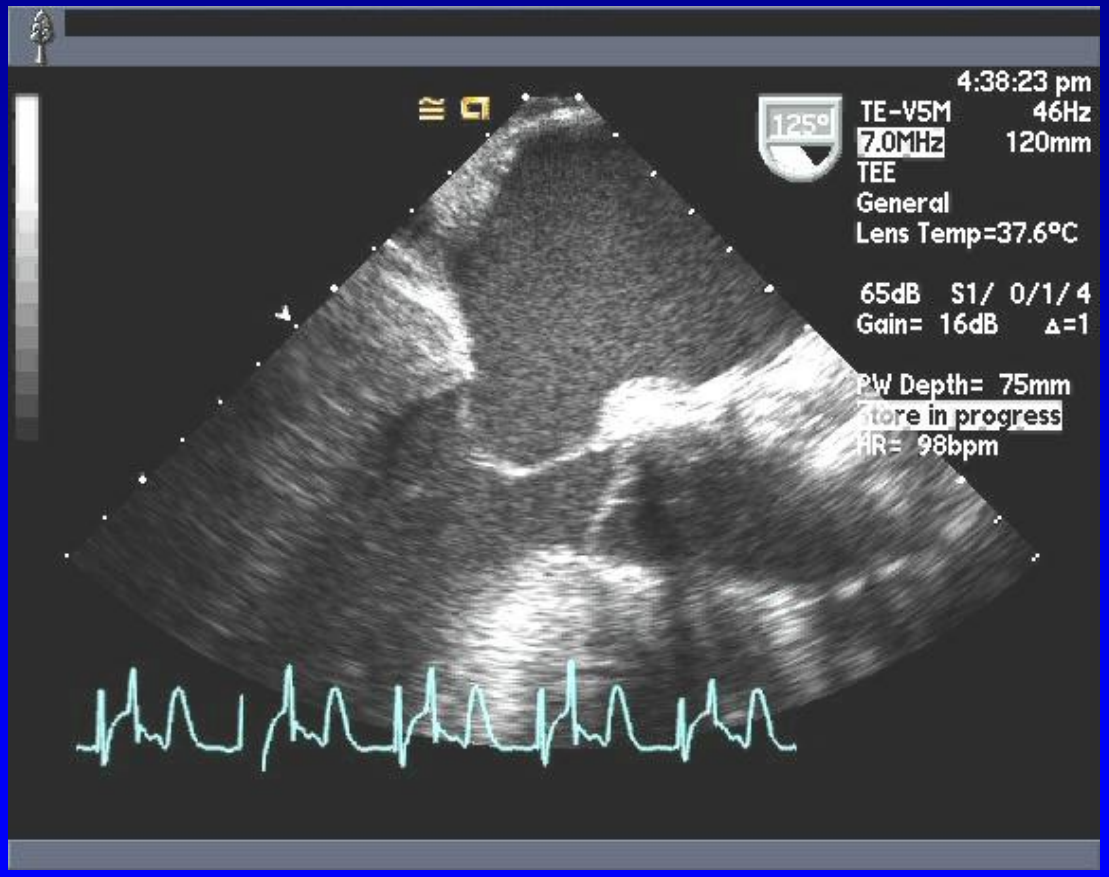
Type A: Pre OP TEE



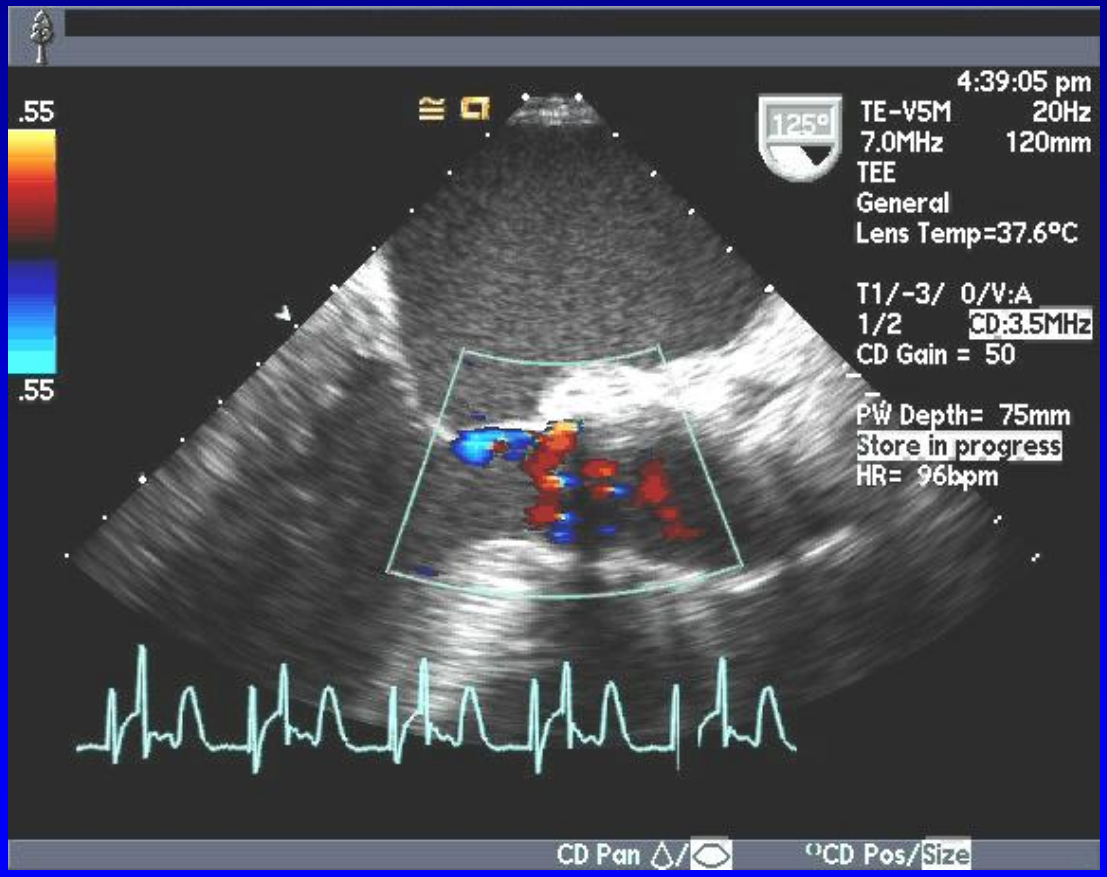
Type A: Pre Op


.55
.55
9:14:08 am
121°
TE-V5M 14Hz
7.0MHz 130mm
TEE
General
Lens Temp<37.0°C
T1/-3/ 0/V:A
1/2 CD:3.5MHz
CD Gain = 50
PW Depth= 70mm
Store in progress
No R Trig
No trigger detected - defaulting to 1 second capture(s)
CD Pan
CD Pos/Size

Type A: Post Op



Type A: Post Op



2009: Where are We with Surgery for Acute Aortic Dissection?

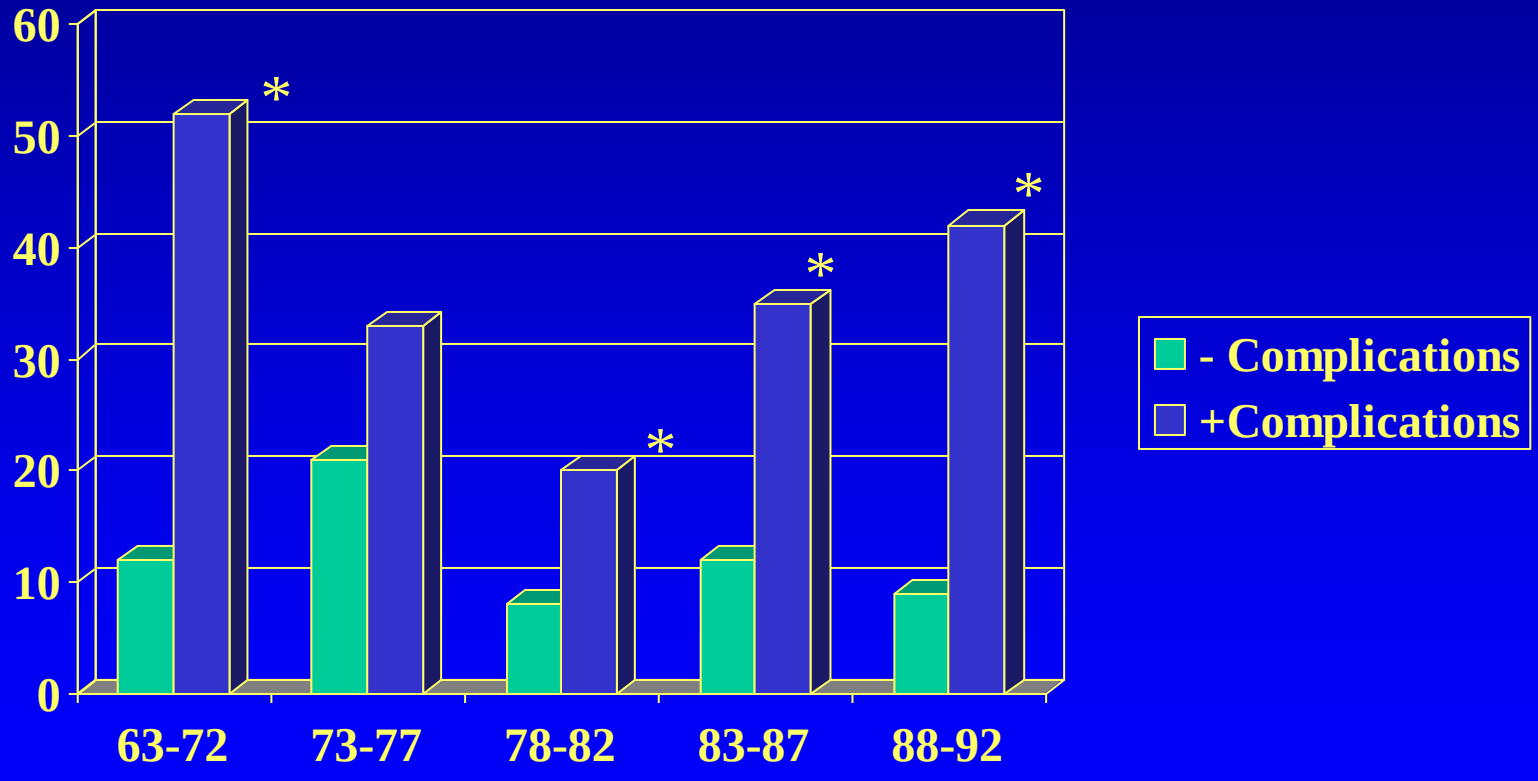
Now the bad news.

Surgical Management

- 30 year experience
- 360 patients, 256 male, age 57 $\pm$ 14
- 174 acute type A (48%)
- Operative mortality 24%

Fann et al, Stanford; Circulation 1995

Aortic Dissection: Surgical Mortality



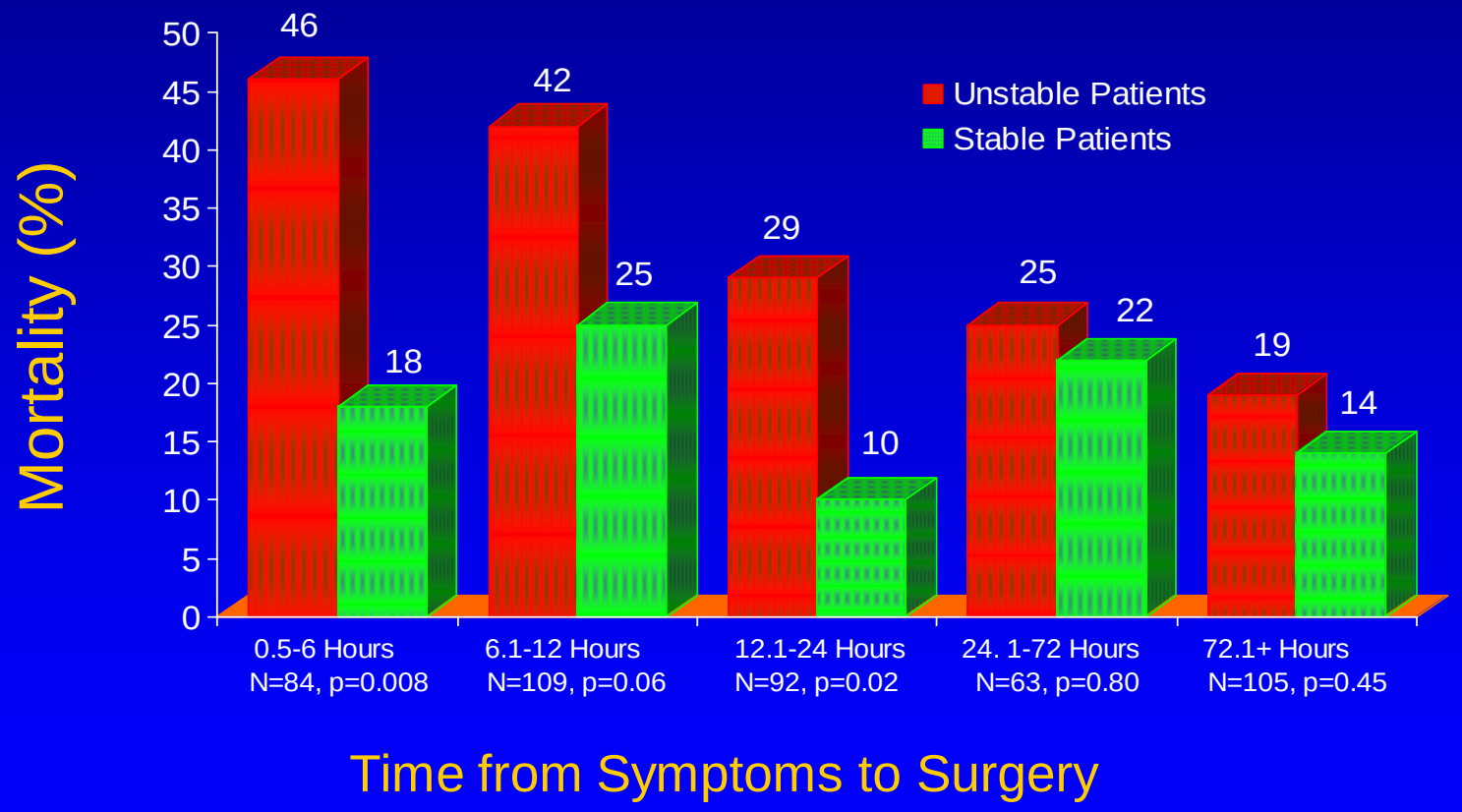
Fann et al. Circulation 1995

Surgical Results for Acute Type A Dissection: IRAD

- 526 patients with acute type A dissection
- Unstable (Group I) if:
  - Cardiac tamponade
  - Shock
  - Coma
  - Stroke
  - Myocardial ischemia / infarction
  - Renal or mesenteric ischemia
- Stable (Group II) in the absence of above
- Valve replaced in 111 (23%)

Trimarchi et al, JTCVS, January 2005

Mortality in Unstable and Stable Patients vs. Time to Surgery



Trimarchi et al. *JTCVS,* January 2005.

Acute Aortic Dissection: Conclusions

- Presentation more variable than traditionally taught
  - It's not just tall people
  - Need to consider early and more often
- Remains highly lethal
  - Mortality often has nothing to do with the heart
- Emergent surgery for type A dissection
  - Definite role for delayed surgery / percutaneous intervention
  - Maybe, just maybe, there is a lower risk Type A population that can be defined by imaging


Go Blue!