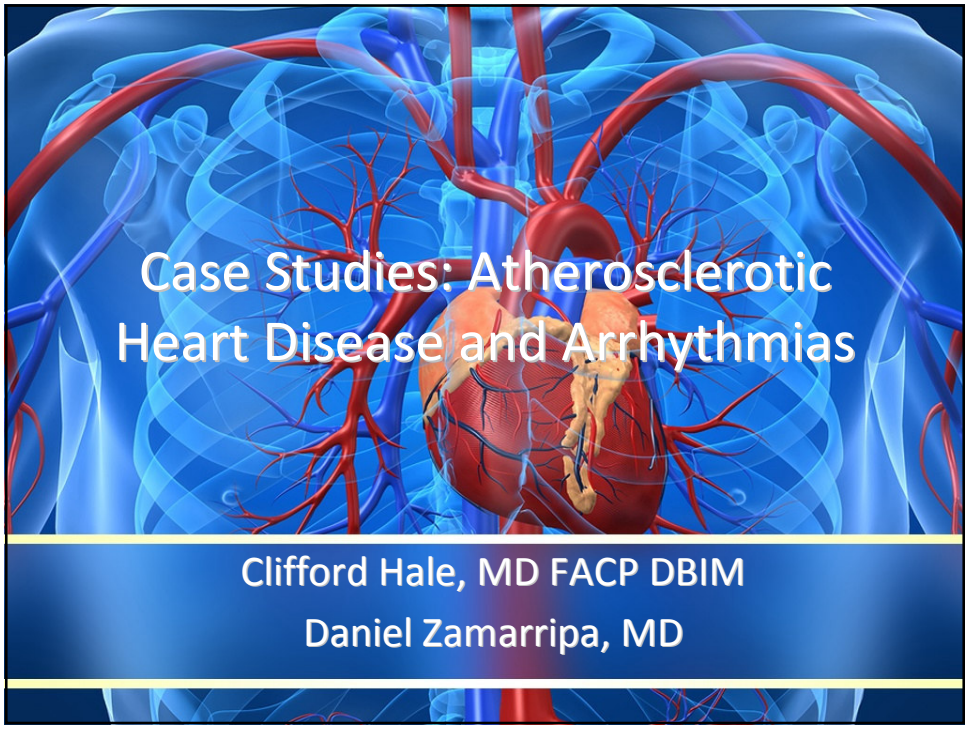


Sensitivity / Specificity for CAD generally defined as >70% stenosis of at least one vessel

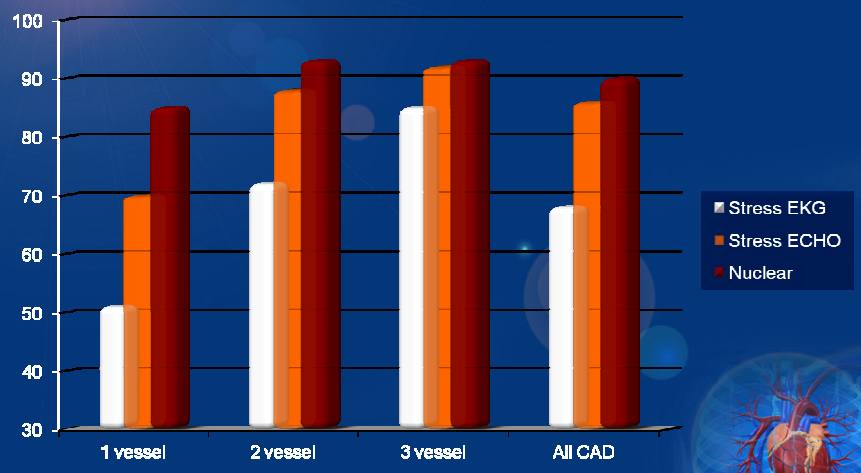
Sensitivity		Specificity	
Stress EKG	68%	Stress EKG	74%
Stress Echo	86%	Stress Echo	77%
Nuclear Stress Test	91%	Nuclear Stress Test	80%
EBCT	93%	EBCT	89%
CCTA	93%	CCTA	96%
Cardiac Cath	99%	Cardiac Cath	99%

Sensitivity = ability to detect disease when it is present .

Specificity = ability to correctly exclude disease when it is absent.

Predictive value influenced by pre-test prevalence or probability.

Sensitivity Comparison of Testing Modalities Based Upon Extent of Disease



Case 1

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    - Cath: 30% proximal RCA; luminal irregularities in the LAD and LCA.

Newly Acquired LBBB in Community Population

Framingham Study Population

- Eighteen years of observation; 55 new LBBBs in 5,209 people
- Average age of onset 62
- Most LBBBs occurred with HTN, CAD, and cardiac enlargement
- 48% developed CAD or CHF at or after onset
- Within 10 years 50% died from cardiovascular disease
- LBBB contributed independently to increased risk of cardiovascular death

Annals of Internal Medicine 1979 90;(3):303

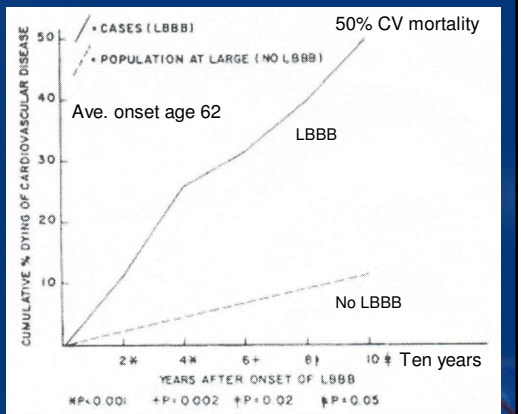
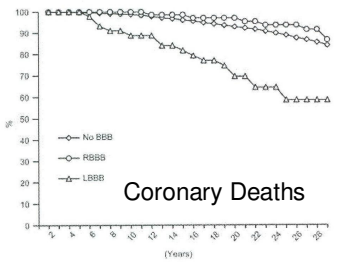


Figure 4. Comparison of cumulative mortality rates from cardiovascular disease in the cases versus the population-at-large free from left bundle-branch block (*LBBB*). Starting point for the mortality rate calculations in the cases was the age at onset of LBBB, and in the population-at-large free from LBBB was the mean age of 62 years.

7,392 Men From a General Population

BBB at Baseline and 28-Year Follow-up

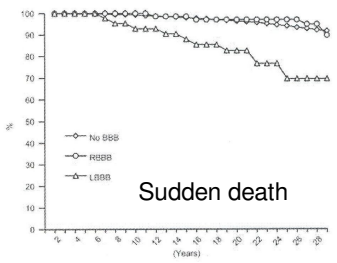
Coronary Death and Sudden Death



Numbers at risk:

Year	0	5	10	15	20	25
No BBB	7276	7118	6804	6281	5588	4406
RBBB	70	70	69	64	58	46
LBBB	46	44	38	34	28	19

Figure 1 Survival curves for coronary deaths in men with left-BBB, right-BBB, and without BBB at baseline.



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LBBB	46	44	38	34	28	19

Figure 2 Survival curves for sudden deaths in men with left-BBB, right-BBB, and without BBB at baseline.

HR LBBB all cause mortality 1.84

European Heart Journal 2005; 26:2300-2306

LBBB in Patients with Chronic CAD

- 15,609 with CAD had coronary angiogram and ventriculography
- 522 had BBB
- BBB did not correlate with location of coronary artery stenosis or LV wall wall abnormality
- 4.9 year follow-up; 2,386 died
- Those with **LBBB had a 5X mortality risk**
- Those with **RBBB had 2X mortality risk**
- Cox **regression showed LBBB, but not RBBB, is a strong predictor of mortality in this population**

J Am Coll Cardiol 1987;10:73-80

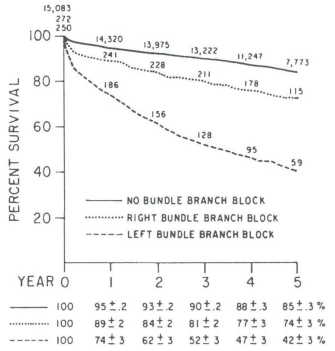
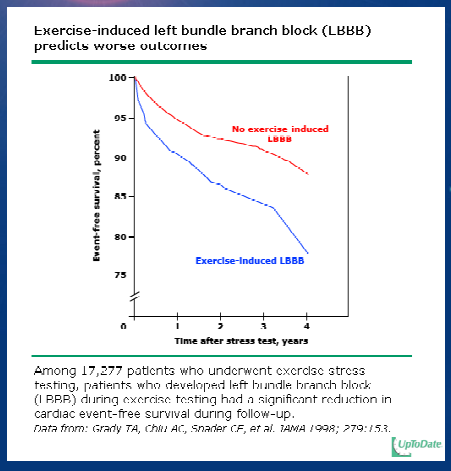


Figure 4. Actuarial survival in 15,083 patients without bundle branch block, 272 with right bundle branch block and 250 with left bundle branch block. The **figures above the curves** denote the number of patients at risk in each group at yearly intervals during follow-up. The **figures below the graph** denote the probability (±SE) of survival of patients in each group at yearly intervals. Differences among the three curves are highly significant ($p < 0.0001$).

Exercise Induced LBBB



- 17,277 exercise tests
- Follow-up 3.7 years
- 70 Exercise induced LBBB
- 25 patients with cardiac events
  - -17 with exercise induced LBBB
  - -8 in control group
- 7 deaths
  - -5 with exercise induced LBBB
  - -2 in control group

J Cardiovasc Electrophysiol 2009; 20:781

Left Anterior Hemiblock and Mortality

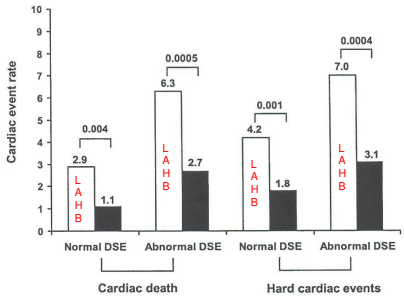


Figure 3. Annual cardiac event rates according to combinations of electrocardiographic and stress echocardiographic findings. **White bars** = LAHB; **black bars** = no LAHB. DSE = dobutamine stress echocardiography; LAHB = left anterior hemiblock.

LAHB and abnormal DSE were at the highest risk of cardiac death.

JACC 2005;46(5):858-63

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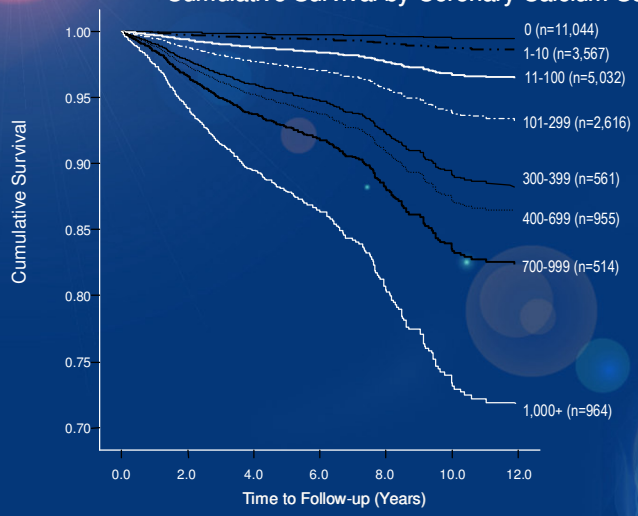
Long-Term Prognosis Associated with Coronary Calcification: Outcomes

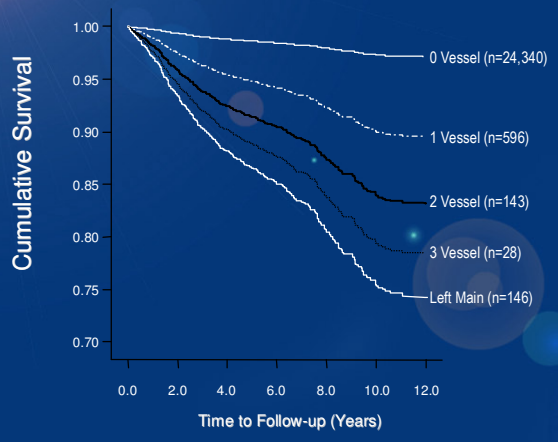
Cumulative Survival by Coronary Calcium Score



JACC 2007; 49: 1860-70

Long-Term Prognosis Associated with Coronary Calcification: Outcomes

Cumulative Survival by the Coronary Calcium Extent in the Number of Vascular Territories



JACC 2007

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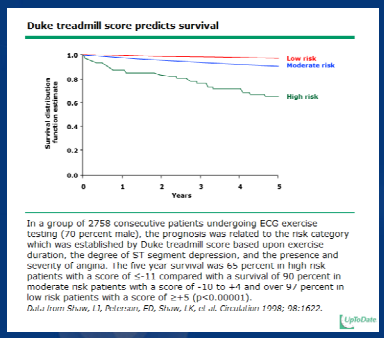
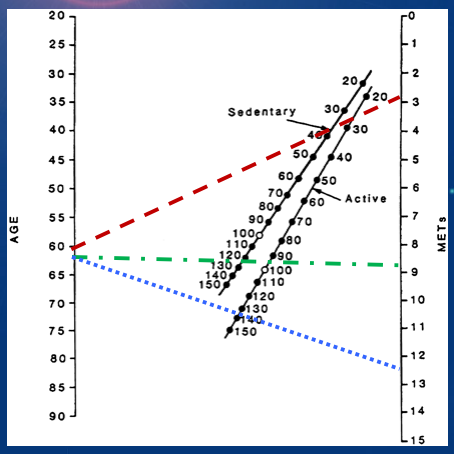
Duke Treadmill Score

- (Bruce exercise minutes) ***minus*** (5 x maximal ST segment deviation in mm) ***minus*** (4 x exercise angina) where
  - 0 = none; 1 = non-limiting; 2 = limiting



- Low risk – score ≥ +5
  - (97% five-year survival)
- Moderate risk – score from -10 to + 4
  - (31% have 3-vessel or LM disease with 90% five year survival)
- High Risk – score <-11
  - (74% have 3-vessel or LM disease with 65% five year survival)

Estimating Expected Exercise Capacity for Age



For example, a 60-year-old man with a 3-MET capacity has 40% of the age-expected exercise capacity for sedentary men and 30% of that for active men. *

A useful equation to estimate *expected* METs for an active person

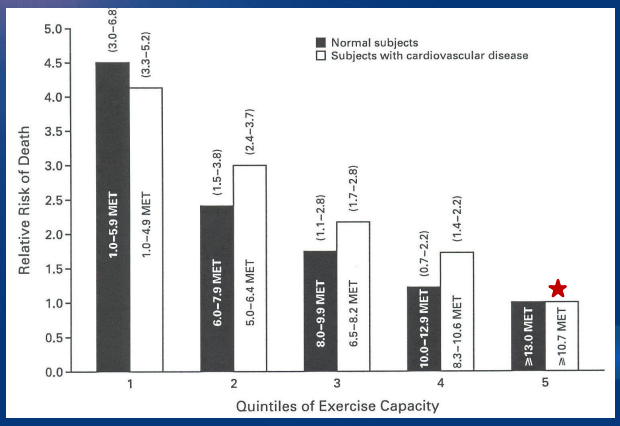
18 – (age x 0.15) = Expected METs

Case 1 expected
18 – (61 x 0.15) = 8.85 METs

Case 1 achieved = 12.5 METs

* This statement was approved by the American Heart Association Science Advisory and Coordinating Committee in June 2001.

Exercise Capacity and All-Cause Mortality

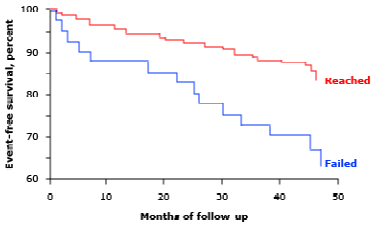


Myers J et al. N Engl J Med 2002;346:793-801.

The NEW ENGLAND JOURNAL of MEDICINE

Chronotropic Insufficiency

Ability to achieve goal heart rate during exercise treadmill testing correlates with better outcomes



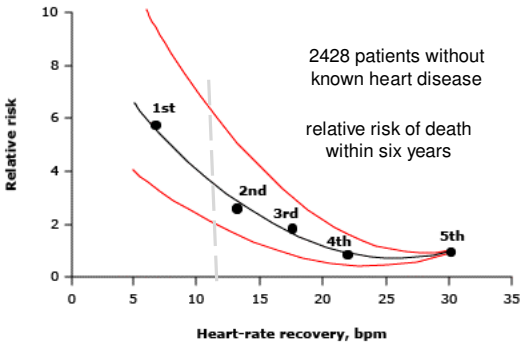
Among 231 consecutive patients referred for exercise testing who were not taking a beta blocker, the inability to achieve at least 85 percent of age predicted maximal heart rate was associated with a lower event-free survival compared to those who reached this heart rate (adjusted relative risk 2.2).
Data with permission from: Lauer MS, Mehta R, Pashkow FJ, et al. J Am Coll Cardiol 1998; 32:1280.

UpToDate

Unable to achieve 85% predicted max HR off beta blockers

Adjusted relative risk of cardiac event 2.2

Heart-Rate Recovery
One Minute after Peak Exercise.



2428 patients without known heart disease

An abnormal value for the recovery of heart rate defined as a reduction of ≤12 beats per minute (bpm) from the heart rate at peak exercise

Circles represent the relative risk of death within six years for each of the quintiles as compared with the fifth quintile which had the lowest risk of death

Red lines represent the 95 percent confidence interval.

Cole CR et al. N Engl J Med 1999;341:1351-1357.

the NEW ENGLAND JOURNAL of MEDICINE

Mortality Risk in Normotensive Individuals with Hypertensive Response to Exercise

6578 asymptomatic individuals (74 percent without hypertension at baseline) who underwent submaximal Bruce treadmill tests and were followed for 20 years

Among individuals with baseline BP <140/90 mmHg, Bruce stage 2 BP >180/90 compared to ≤180/90 mmHg was associated with a significant increase in risk of cardiovascular death after adjustment for rest BP and other risk factors (adjusted hazard ratio for systolic 1.96, 95% CI 1.40-2.74 and for diastolic 1.48, 95% CI 1.06-2.06).

Weiss S A et al. Circulation 2010;121:2109-2116

Case 1

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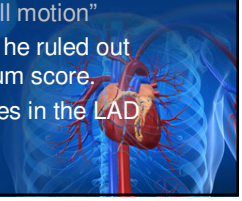
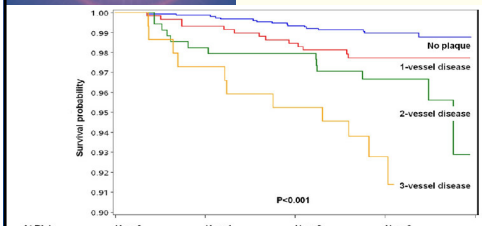
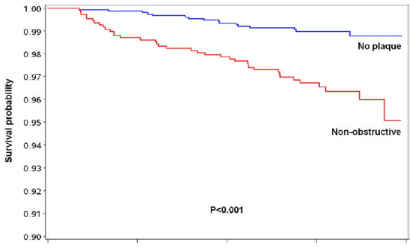


Mortality Risk in Symptomatic Patients With Nonobstructive Coronary Artery Disease

A Prospective 2-Center Study of 2,583 Patients Undergoing 64-Detector Row Coronary Computed Tomographic Angiography

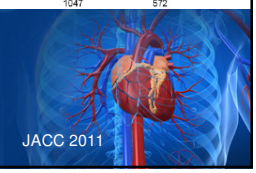


At Risk	Year 0	Year 1	Year 2	Year 3
No Plaque	1509	1507	1499	897
1-Vessel Disease	583	579	574	314
2-Vessel Disease	340	334	333	184
3-Vessel Disease	147	143	140	74



At Risk	Year 0	Year 1	Year 2	Year 3
No Plaque	1509	1507	1499	897
Non-Obstructive	1070	1056	1047	672

Adjusted for CAD risk factors, the presence of any nonobstructive plaque was associated with higher mortality with the highest risk among those exhibiting nonobstructive CAD in 3 vessels

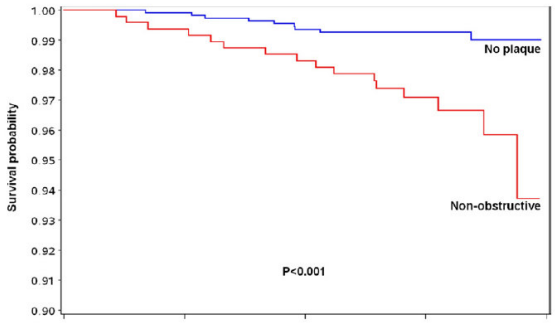


JACC 2011

Mortality Risk in Symptomatic Patients With Nonobstructive Coronary Artery Disease

A Prospective 2-Center Study of 2,583 Patients Undergoing 64-Detector Row Coronary Computed Tomographic Angiography

Higher mortality for non obstructive CAD was observed even among patients with low 10-year Framingham risk (3.4%, p=0.0001) as well as those with no traditional, medically treatable CAD risk factors, including diabetes mellitus, hypertension, and dyslipidemia (6.7%,p=0.0001)



At Risk	Year 0	Year 1	Year 2	Year 3
No Plaque	1085	1084	1078	649
Non-Obstructive	471	468	463	251

Figure 4 Prognosis of Nonobstructive CAD in Low-Risk Patients

Unadjusted all-cause 3-year Kaplan-Meier survival by the absence of coronary artery disease (CAD) versus presence of nonobstructive CAD in patients with a 10-year Framingham estimated risk <10%.

JACC 2011

Case 1: Relative Mortality Risk?

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Relative Mortality

- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 2

47-year-old male dentist and marathon runner with history of childhood asthma and atrial fibrillation since 1999. Drinks alcohol socially once or twice weekly

Atrial Fibrillation History:

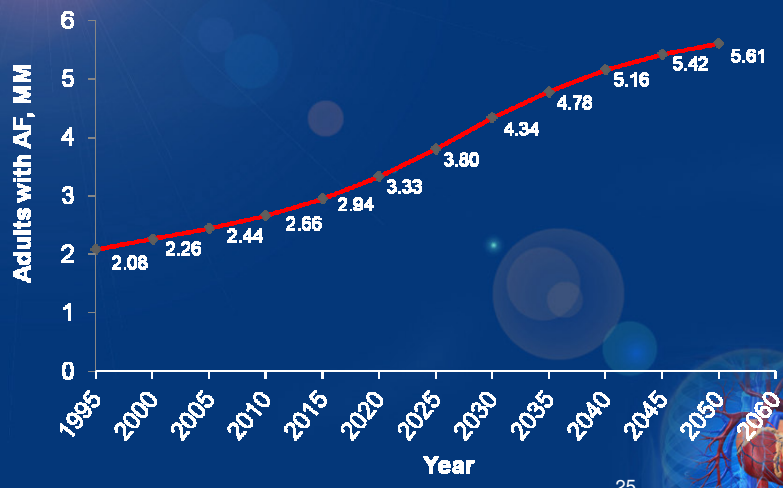
March1998: first episode AF, spontaneously converted

September 2007: initiated warfarin and atenolol followed by cardioversion

February 2009: atrial fibrillation walking up stairs; reinitiated warfarin and atenolol followed by cardioversion

March 2009: pulmonary vein isolation: six-week follow up with only one brief episode of AF, nothing sustained. Six and twelve-month follow up: No atrial fibrillation

Projected Number of Adults With AF in the US: 1995 to 2050

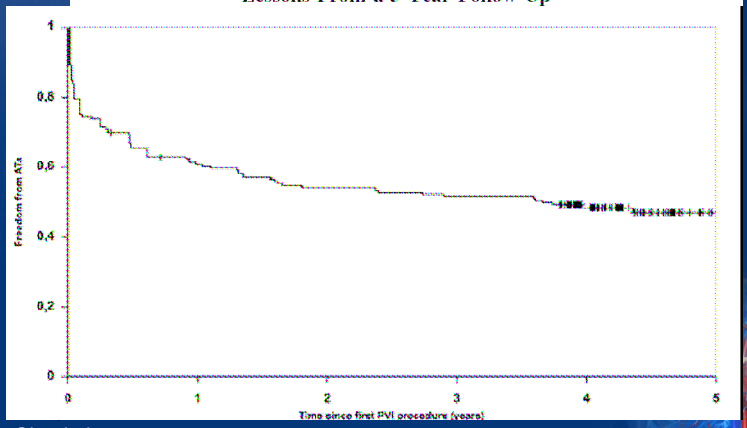


Go A, JAMA. 2001

Time since *First* Pulmonary Vein Isolation (PVI)

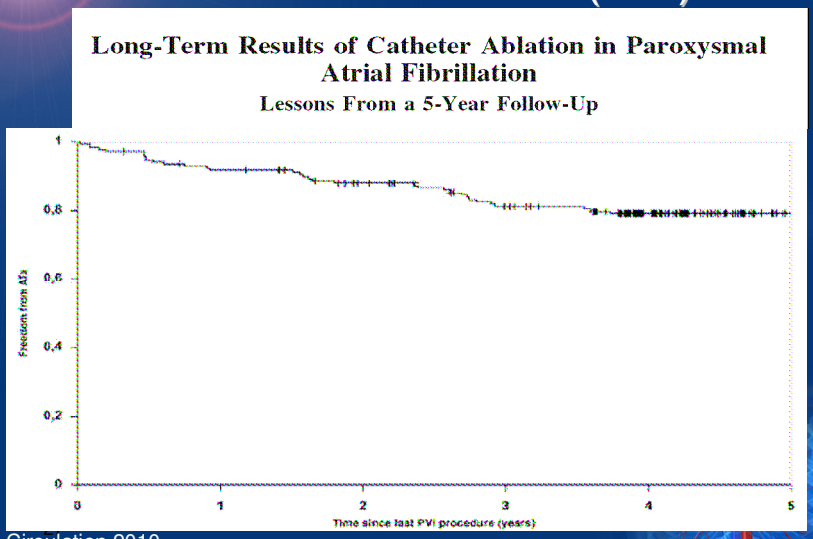
Long-Term Results of Catheter Ablation in Paroxysmal Atrial Fibrillation

Lessons From a 5-Year Follow-Up



Ouyang Circulation 2010

Time since *Last* Pulmonary Vein Isolation (PVI)



Ouyang Circulation 2010

Stroke in AF

- Stroke in AF is often severe and results in long-term disability or death. Approximately every fifth stroke is due to AF; furthermore, undiagnosed 'silent AF' is a likely cause of some 'cryptogenic' strokes. Paroxysmal AF carries the same stroke risk as permanent or persistent AF
- Cognitive dysfunction, including vascular dementia, may be related to AF. Small observational studies suggest that asymptomatic embolic events may contribute to cognitive dysfunction in AF patients in the absence of an overt stroke.

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Relative Mortality

- **100 %**
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- **300 %+**

Case 3

75-year-old male ex-smoker with exemplary cardiovascular risk factors evaluated in 2006 (age 69) for dyspnea and a positive stress test

2006 SPECT: Symptom-limited stress ECG showed 3 mm downsloping ST depression at 8.2 METs.

Resting EF 55%; stress EF 60%; TID ratio 1.2; 4% reversible defect RCA distribution

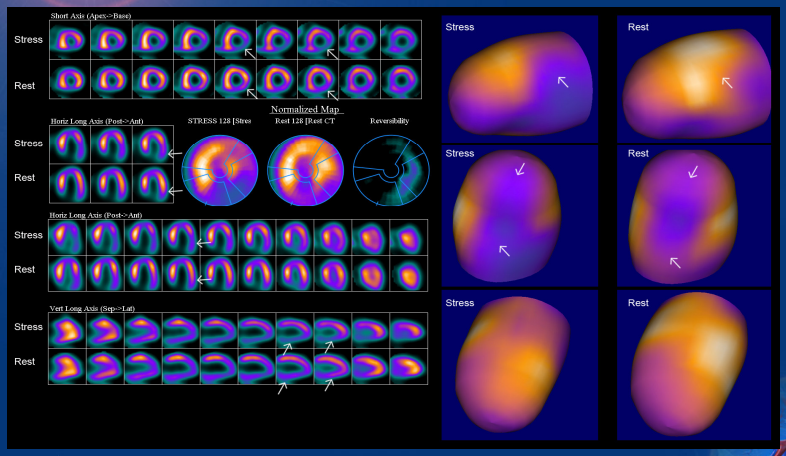
CT Angiogram: Ca++ score 598 (82 %-tile). Prox LAD 25-49%; 1st diag. 30% ostial; prox. RCA 1-24%; mid-RCA 25-49%, and ostial PDA 1-24%

2010 SPECT : Symptom-limited stress to 7.7 METs with 3mm ST depression. New 12% reversible defect RCA distribution. EF 58%.

2010 CTA: calcium score 770 (87th percentile). LAD score 495. RCA: 192

Myocardial Perfusion Imaging (MPI)

SPECT, Radionuclide Scan, Nuclear Scanning



Myocardial Perfusion Imaging with Exercise or Pharmacologic Stress

Imaging agents

Thallium-201 (K+)
Tc-99m sestamibi (Ca++)
(e,g,. Cardiolite)
Technitium tetrofosmin
(e.g., Myoview)
Technitium teboroxime
(e.g.,Cardiotec)

Indications for Pharmacologic Stress

Unable to exercise
Aortic stenosis
LBBB
Pacemaker
Recent MI
Severe HTN

Pharmacologic Stress

Vasodilators (“stealers”)
- Adenosine and analogs
- Dipyridamole

Inotrope/Chronotrope
- Dobutamine

Transient Ischemic Dilation Ratio (TID)

Average ventricular size after stress compared with rest

Table 1. Distribution of the Study Population 1 by Quartiles of TID Ratio

Subgroup	Number of Patients	Mean ± SD of TID Ratio	Range of TID Ratio (Minimum-Maximum)
1st quartile	361	0.93 ± 0.06	0.80–0.99
2nd quartile	400	1.02 ± 0.02	1.00–1.07
3rd quartile	409	1.13 ± 0.04	1.08–1.20
4th quartile	390	1.35 ± 0.14*	1.21–1.79

*p = 0.001 across the groups.
TID = transient ischemic dilation.

JACC 2003; 42:1818-1825

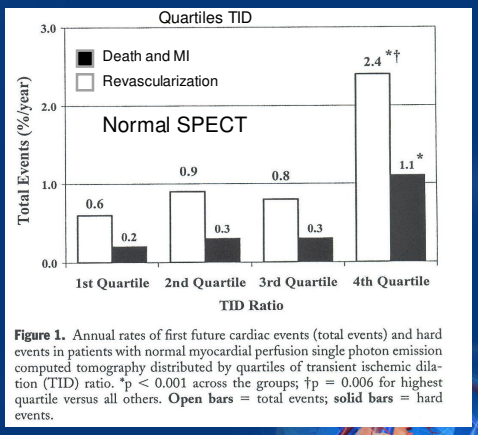


Figure 1. Annual rates of first future cardiac events (total events) and hard events in patients with normal myocardial perfusion single photon emission computed tomography distributed by quartiles of transient ischemic dilation (TID) ratio. *p < 0.001 across the groups; †p = 0.006 for highest quartile versus all others. **Open bars** = total events; **solid bars** = hard events.

TID ratios > 1.22 with exercise or > 1.36 with pharmacologic stress suggest extensive CAD, even in presence of normal MPI.

(71% sensitivity and 95% specificity)

JACC 1996;27:1612-1620 J Nucl Cardiol 1999;6:397-405

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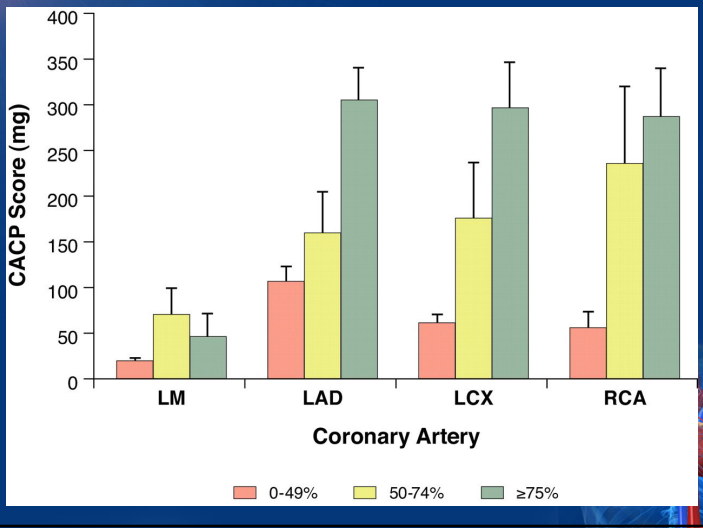
2010 CTA: calcium score 770 (87th percentile). LAD score 495. RCA, 192

Silent Lesions (<50%)

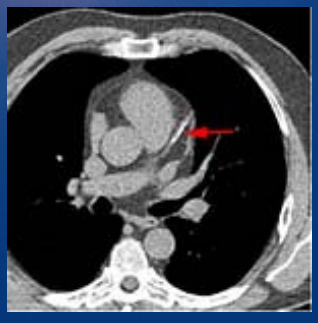
Relationship Between Calcium Score and the Severity of Coronary Artery Stenosis



Slide 35

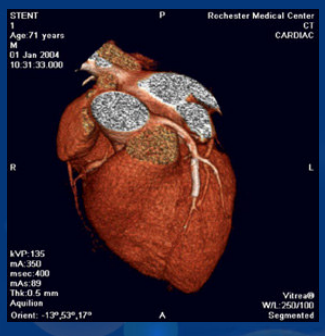
Newer Anatomic Imaging

Calcium score



Rapid x-ray of the heart allowing for the detection of calcium buildup in the coronaries.
Density x brightness=Agaston score

CCTA



3 D reconstruction of the heart and blood vessels developed from data acquired by a CT technology that allows for increased spatial and temporal resolution.

Slide 36

CTA *Will* Replace Diagnostic Invasive Angiography

- Accurate

	Sensitivity	Specificity	Negative Protective Value
Per segment	91%	96%	98%
Per patient	96%	90%	99%

- Prognostic value

486 suspected acute coronary syndrome patients in ER:
84% discharged home after normal CT
30 days: no events
1 year: no MI

Ann Emerg Med 2009

Case 3 Relative Mortality Risk?

75-year-old male ex-smoker with exemplary cardiovascular risk factors evaluated in 2006 (age 69) for dyspnea and a positive stress test

2006 SPECT: Symptom-limited stress ECG showed 3 mm downsloping ST depression at 8.2 METs.

Resting EF 55%; stress EF 60%; TID ratio 1.2; 4% reversible defect RCA distribution

CT Angiogram: Ca++ score 598 (82 %-tile). Prox LAD 25-49%; 1st diag. 30% ostial; prox. RCA 1-24%; mid-RCA 25-49%, and ostial PDA 1-24%

2010 SPECT : Symptom-limited stress to 7.7 METs with 3mm ST depression. New 12% reversible defect RCA distribution. EF 58%

2010 CTA: calcium score 770 (87th percentile). LAD score 495. RCA, 192

Relative Mortality

- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 4

62-year-old male investment advisor with history of an “abnormal ECG” since 1988 (age 38) and echocardiographic evidence of an MI in 1996 (age 46).

5’8” 167 lbs (BMI 25) BP 132/75 with an exemplary risk factor profile. Good medical records depict excellent care and good health otherwise.

March 2011 SPECT 8.0 METs (2006: 10 METs):

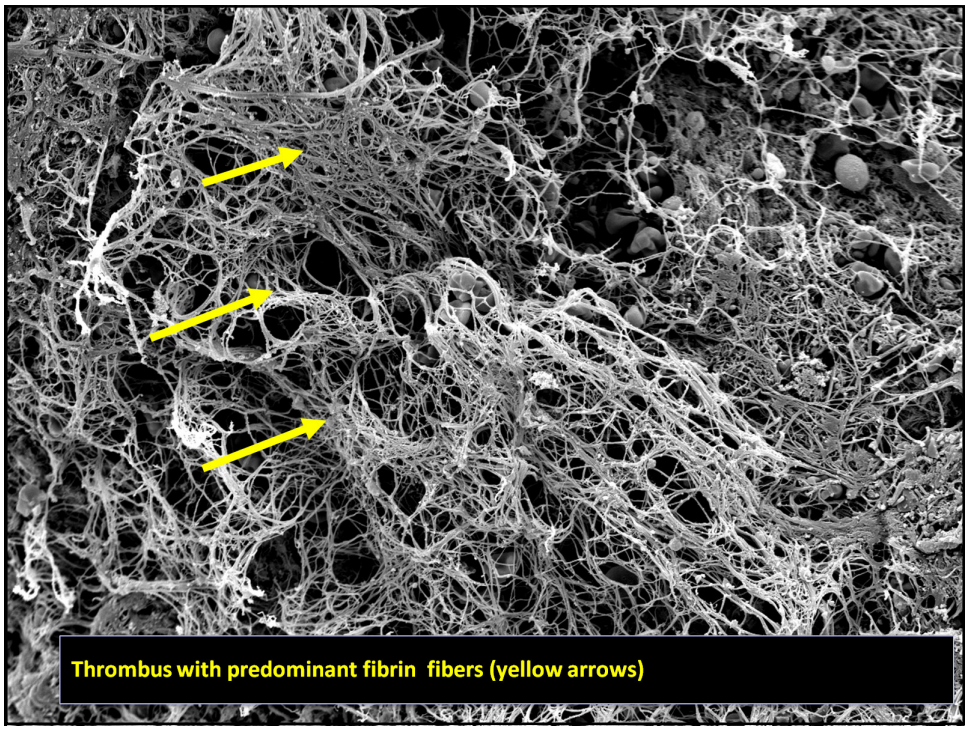
ECG: positive 2mm ST depression five minutes into exercise resolving two minutes into recovery

SPECT: moderate to severe fixed perfusion defect anterior wall, post stress ejection fraction 37% (post stress EF 2006 51%)

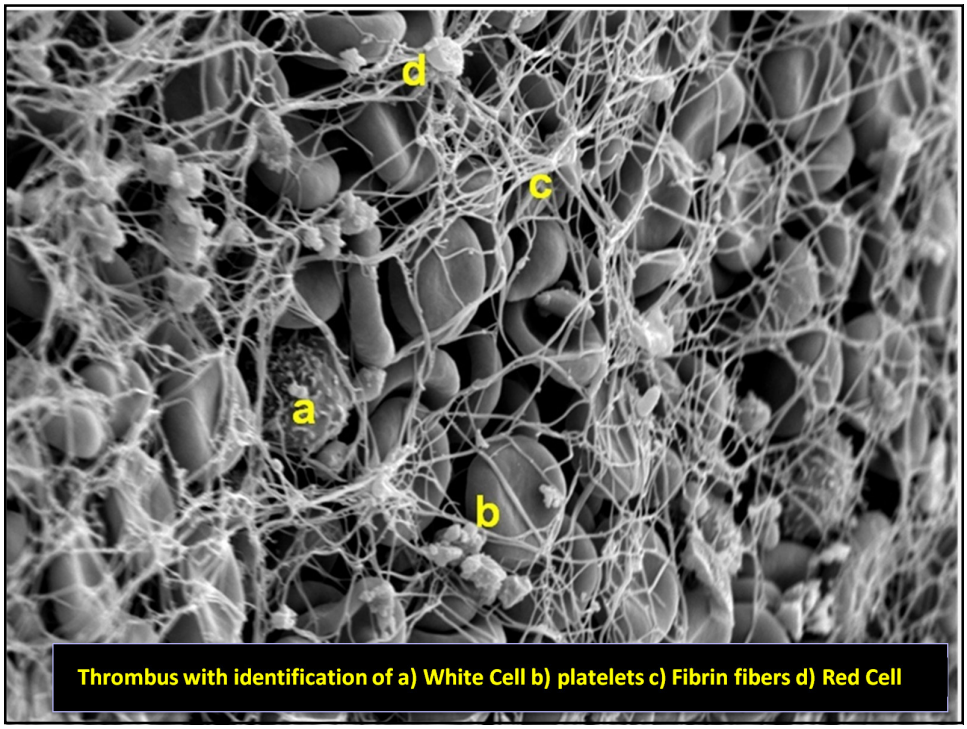
Echocardiogram : LVID 6.0, LA 3.6, Septum 1.0, PW 1.2, resting EF 50%, and mild anteroseptal hypokinesis

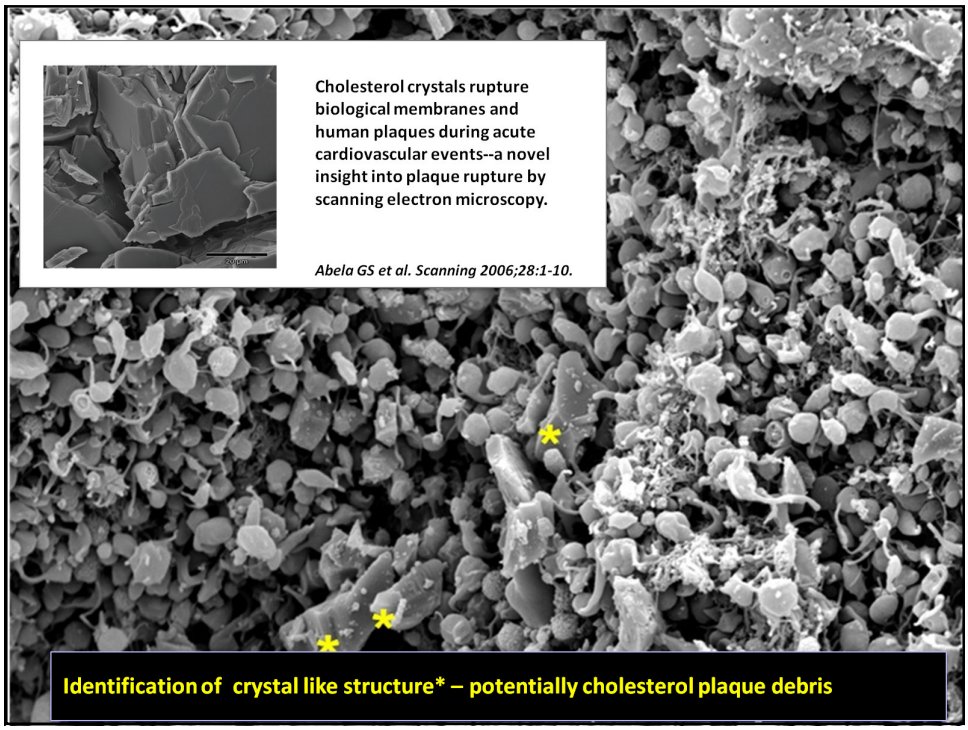
ECG: QS V1-V3; IVCD (QRS 0.14)

June 2012 SPECT (10 METs): ECG and SPECT unchanged except stress EF back to 51%



Thrombus with predominant fibrin fibers (yellow arrows)


d
c
a
b
Thrombus with identification of a) White Cell b) platelets c) Fibrin fibers d) Red Cell


Cholesterol crystals rupture biological membranes and human plaques during acute cardiovascular events--a novel insight into plaque rupture by scanning electron microscopy.
Abela GS et al. Scanning 2006;28:1-10.
*
*
*
Identification of crystal like structure* – potentially cholesterol plaque debris

Left Ventricular Ejection Fraction (EDV-ESV)/EDV

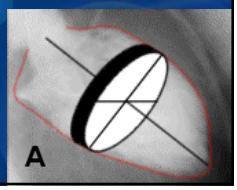
Modality

- M-mode echocardiography
- 2-D echocardiography
- 3-D echocardiography
- MRI*
- CT
- Nuclear Cardiac Imaging
  - SPECT
  - MUGA* (RGV, RNA RNCA ERNA)

- Modified Quinones (planar)
- Modified Simpson (biplane method of disks)*

Sources of Error

- Gating and rhythm abnormalities
- Identifying the endocardial border
- Detecting end-systole and end-diastole
- Software algorithm variations
- Geometric assumptions
- Image planes
- Regional wall motion variations
- Acoustic windows
- Anatomic variations

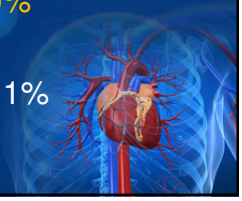


*Recommended by the American Society of Echocardiography
* Most reliable non-invasive methods

Comparing LVEF by Echo, MPI (SPECT), and MRI

52 patients with chronic stable heart failure

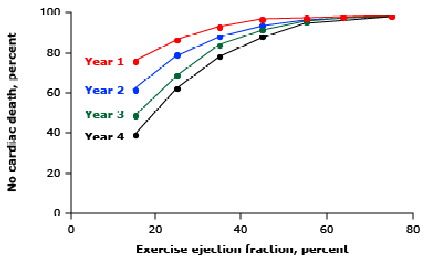
- Echo M-Mode cube method — 39 ± 16%
- Echo M-Mode Teichholz method — 29 ± 15%
- Echo 2-D Simpsons Biplane — 31 ± 10%
- Radionuclide Ventriculography — 24 ± 9%
- Cardiovascular MR — 30 ± 11%



Eur Heart J 2000; 21, 1387-1396

Exercise Ejection Fraction

The exercise ejection fraction predicts survival in coronary heart disease



Among 908 patients with coronary heart disease who underwent rest and exercise radionuclide angiography and were followed for an average of 4.6 years, the exercise ejection fraction (EF) predicted total cardiac death as well as total cardiac events during each year of followup; patients with an EF 50 percent.

Data from Johnson, SH, Bigelow, C, Lee, KL, et al. Am J Cardiol 1991; 67:919.

UpToDate

Case 4

62-year-old male investment advisor with history of an abnormal ECG since 1988 (age 38) and echocardiographic evidence of an MI in 1996 (age 46).

5'8" 167 lbs (BMI 25) BP 132/75 with an exemplary risk factor profile. Good medical records depict excellent care and good health otherwise.

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ECG: positive 2mm ST depression five minutes into exercise resolving two minutes into recovery

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Echocardiogram : LVID 6.0, LA 3.6, Septum 1.0, PW 1.2, resting EF 50%, and mild anteroseptal hypokinesis

ECG: QS V1-V3; IVCD (QRS 0.14)

June 2012 SPECT (10 METs): ECG and SPECT unchanged except stress EF back to 51%

Non-BBB IVCD

10,899 subjects *general* population 30 years QRS ≥ 0.11

	HR All-Cause Death	HR Cardiac Death	HR Arrhythmic Death
QRS > 0.11	1.48	1.94	2.14
QRS > 0.11 without BBB Pattern	2.01	2.53	3.11

Circulation: Arrhythmia and Electrophysiology 2011; 4:704-710

Case 4: Relative Mortality Risk?

62-year-old male investment advisor with history of an abnormal ECG since 1988 (age 38) and echocardiographic evidence of an MI in 1996 (age 46).

5'8" 167 lbs (BMI 25) BP 132/75 with an exemplary risk factor profile. Good medical records depict excellent care and good health otherwise.

March 2011 SPECT 8.0 METs (2006: 10 METs):

ECG: positive 2mm ST depression five minutes into exercise resolving two minutes into recovery

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Echocardiogram : LVID 6.0, LA 3.6, Septum 1.0, PW 1.2, resting EF 50%, and mild anteroseptal hypokinesis

ECG: QS V1-V3; IVCD (QRS 0.14)

June 2012 SPECT (10 METs): ECG and SPECT unchanged except stress EF back to 51%

Relative Mortality

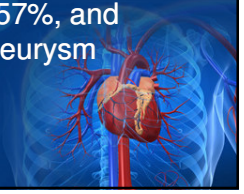
- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 5

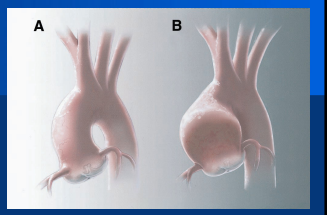
64-year-old physically active dentist. Due to palpitations he had an echocardiogram in December 2004 that revealed a bicuspid aortic valve, aortic root 3.8 cm, moderate LVH and mild AI.

He went to different cardiologist in March 2006. Again an echocardiogram showed a bicuspid aortic valve, an aortic root of 4.4 cm, mild AI, and an EF of 55-60%.

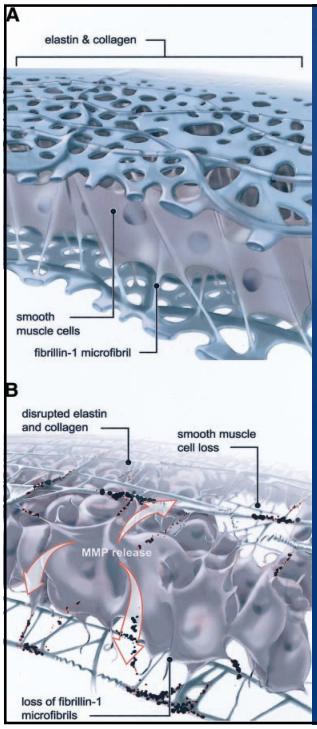
In March 2008 his echo showed his aortic root at 4.2 cm, his left atrial dimension of 3.5 cm, a LVID of 6.1, an EF of 57%, and moderate AI. A CT of the chest to r/o a thoracic aneurysm showed the aortic root at 4.7.



Bicuspid Aortic Valve



- Male > female (2:1)
- Usually picked up between age 40 and 60
- Associated with congenital aortic and proximal coronary artery problems (Marfan's; Ehlers Danlos)
- About half are associated with widened and expanding aortic root and ascending aorta due to (cystic medial degeneration).
- Increased risk of aortic aneurysm and dissection (5-9 x)
- Nearly all require surgery during lifetime



Bicuspid Aortic Valve and Cystic Medial Degeneration

Retrospective Look at Aortic Valve Replacements

Nearly all bicuspid valves require surgery during lifetime

Aortic valve replacements

- 7% replaced before age 50 with 2/3 bicuspid
- 40% between age 50 and 70 with 2/3 bicuspid
- 50%+ after age 70 with 40% bicuspid valves

- Risk rises with aortic insufficiency, aortic stenosis, and enlarged aortic root, especially > 45mm.

Case 5: Relative Mortality Risk

64-year-old physically active dentist. Due to palpitations he had an echocardiogram in December 2004 that revealed a bicuspid aortic valve, aortic root 3.8 cm, moderate LVH and mild AI.

He went to different cardiologist in March 2006. Again an echocardiogram showed a bicuspid aortic valve, an aortic root of 4.4 cm, mild AI, and an EF of 55-60%.

In March 2008 his echo showed his aortic root at **4.2** cm, his left atrial dimension of 3.5 cm, a LVID of 6.1, an EF of 57%, and moderate AI. A CT of the chest to r/o a thoracic aneurysm showed the aortic root at 4.7 cm.

Relative Mortality

- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 6

75-year-old retired school teacher with controlled hypertension. As part of the physical exam she had an echocardiogram that led to a chest CT.

Chest CT December 2009

Aortic root 4.1 cm

Ascending aorta is prominent measuring 3.9 cm in the mid-ascending segment.

Proximal Aortic Arch 3.9 cm

Descending thoracic aorta 2.7 cm

Case 6 . . . Cont.

Same retired 75-year-old school teacher two years later:

Chest CT December 2011:

Study described as “unchanged” from December 2009

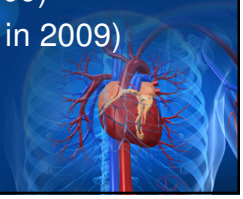
Aortic root 4.2 cm (was 4.1 cm 2009)

Ascending aorta 4.1 cm in the mid-ascending segment (was 3.9 cm in 2009)

Proximal Aortic Arch 4.2 cm (was. 3.9 cm in 2009)

Descending thoracic aorta **3.2** cm (was 2.7 cm in 2009)

No evidence of dissection.



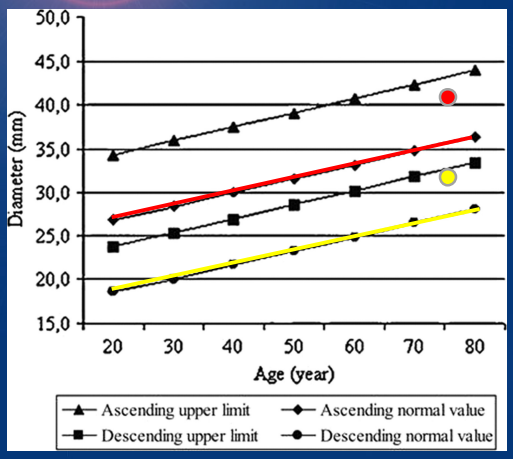
Five-year Risk of Rupture Thoracic Aneurysm

The 5-year risk of rupture as a function of aneurysm size at recognition was:

- 0% for aneurysms less than 4 cm in diameter
- 16% (95% CI, 4%-28%) for those 4 to 5.9 cm, and
- 31% (95% CI, 5%-56%) for aneurysms 6 cm or more.

JAMA 1998 280;22:1926

Normal Diameter and Upper Limit of Ascending and Descending Aorta Related to Age



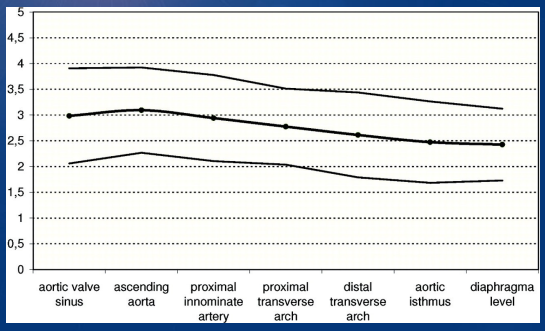
WRITING GROUP MEMBERS et al. Circulation 2010;121:e266-e369

Our 75-year-old
2009 to 2011
Aortic root 4.1 – 4.2
Ascending 3.9 – 4.1
Descending 2.7 – 3.2

Average Growth Rate
Ascending thoracic: **0.07 cm/yr**
Descending thoracic: **0.19 cm/yr**

Ann Thorac Surg 2002;74:S1877-80

Mean aortic diameters (in cm) at various levels measured by helical CT in 70 adults.



Average Growth Rate
Ascending thoracic: 0.07 cm/yr
Descending thoracic: 0.19 cm/yr

Male
Aortic sinus: 3.63 to 3.91 cm
Ascending aorta: 2.86 cm
Mid-descending aorta: 2.39 to 2.98 cm
At diaphragm: 2.43 to 2.69 cm

Female
Aortic root: 3.5 to 3.72 cm
Ascending aorta: 2.86 cm
Mid-descending aorta: 2.45 to 2.64 cm
At diaphragm: 2.40 to 2.44 cm

WRITING GROUP MEMBERS et al. Circulation 2010;121:e266-e369

Case 6: Relative Mortality Risk?

75-year-old retired school teacher with controlled hypertension. As part of the physical exam she had an echocardiogram that led to a chest CT.

Chest CT December 2009
Aortic root 4.1 cm
Ascending aorta is prominent measuring 3.9 cm in the mid-ascending segment.
Proximal Aortic Arch 3.9 cm
Descending thoracic aorta 2.7 cm

Chest CT December 2011:
Study described as "unchanged" from December 2009
Aortic root 4.2 cm (was 4.1 cm 2009)
Ascending aorta 4.1 cm in the mid-ascending segment (was 3.9 cm in 2009)
Proximal Aortic Arch 4.2 cm (was. 3.9 cm in 2009)
Descending thoracic aorta **3.2** cm (was 2.7 cm in 2009)
No evidence of dissection.

Relative Mortality

- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 7

65-year-old mechanical engineer with statin-treated hyperlipidemia and well-controlled hypertension. Height 72" and weight 215 pounds. BMI 28.5 BSA 2.175 m^2

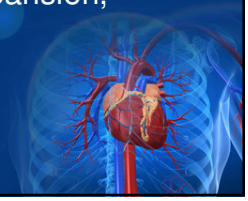
In May 2010 due to non-specific abdominal pain he had an abdominal ultrasound that showed an abdominal aorta of 4.3 cm

(a) Scenario
May 2012 abdominal ultrasound reveals AAA 4.3 cm

(b) Scenario
Same as (a) except that AAA size is 4.6 cm

Abdominal Aortic Aneurysm

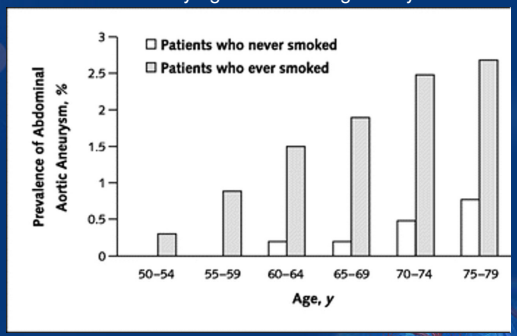
- A focal dilatation with at least a 50% increase over the normal diameter, 3 cm for the abdominal aorta.
- Highly correlated with atherosclerosis, endothelial dysfunction, and the inflammatory mediators that mediate endothelial dysfunction.
- Rupture risk is related to diameter, rate of expansion, and gender.



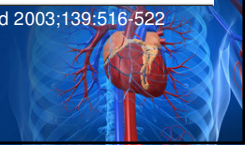
Cardiovascular Risk Factors Aggravate Aortic Aneurysms

Aortic aneurysms are highly correlated with atherosclerosis and aggravated by factors that accelerate atherosclerosis, especially tobacco smoking.

Prevalence of abdominal aortic aneurysm 4.0 cm or larger in men by age and smoking history



Lederle, F. A. Ann Intern Med 2003;139:516-522



Annual Risk of Rupture of Abdominal Aortic Aneurysm

• < 4.0 cm;	zero risk
• 4.0 to 4.9 cm	0.5 to 5%
• 5.0 to 5.9 cm	3-15%
• 6.0 to 6.9 cm	10-20%
• 7.0 to 7.9 cm	20 to 40%
• > 8.0 cm	30 to 50%

UpToDate: Natural History and Management of Abdominal Aortic Aneurysm
Authors: Mohler and Fairman
Literature review through August 2012
Last updated June 16, 2011

Abdominal Aneurysm

Growth Rates by Diameter

• 2.8 to 3.9 cm diameter	average growth rate 0.19 cm per year
• 4.0 to 4.5 cm diameter	average growth rate 0.27 cm per year
• 4.6 to 8.5 cm diameter	average growth rate 0.35 cm per year

Growth rates are variable (some don't grow), so serial measurements are necessary.

Growth is more rapid in smokers

UpToDate: Natural History and Management of Abdominal Aortic Aneurysm
Authors: Mohler and Fairman
Literature review through August 2012
Last updated June 16, 2011

Risk of Rupture Relative to Body Surface Area ("Indexed Risk")

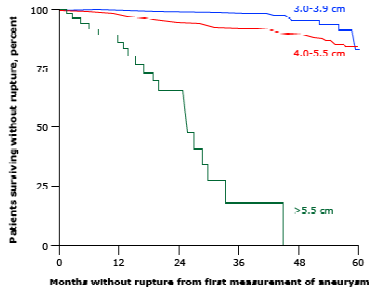
	Aortic size (cm)									
BSA	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
1.30	2.69	3.08	3.46	3.85	4.23	4.62	5.00	5.38	5.77	6.15
1.40	2.50	2.86	3.21	3.57	3.93	4.29	4.64	5.00	5.36	5.71
1.50	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33
1.60	2.19	2.50	2.80	3.13	3.44	3.75	4.06	4.38	4.69	5.00
1.70	2.05	2.35	2.65	2.94	3.24	3.53	3.82	4.12	4.41	4.71
1.80	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17	4.44
1.90	1.84	2.11	2.37	2.63	2.89	3.16	3.42	3.68	3.95	4.22
2.00	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
2.10	1.67	1.90	2.14	2.38	2.62	2.86	3.10	3.33	3.57	3.80
2.20	1.59	1.82 ★	2.05	2.27	2.50	2.72	2.95	3.18	3.41	2.64
2.30	1.52	1.74	1.96	2.17	2.39	2.61	2.83	3.04	3.26	3.48
2.40	1.46	1.67	1.88	2.08	2.29	2.50	2.71	2.92	3.13	3.33
2.50	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20

= low risk (~4% per yr)
= moderate risk (~8% per yr)
= severe risk (~20% per yr)

Ann Thorac Surg 2006;81:169-177 © 2006

Abdominal Aortic Rupture Rates

AAA rupture primarily occurs in larger aneurysms



Risk of rupture of an abdominal aortic aneurysm (AAA) over time according to the first measurement of aneurysm diameter in 1792 men and 465 women. The risk of rupture increased markedly in aneurysms larger than 5.5 cm in diameter.

Data from: Powell, JT, Greenhalgh, RM, N Engl J Med 2003; 348:1895.

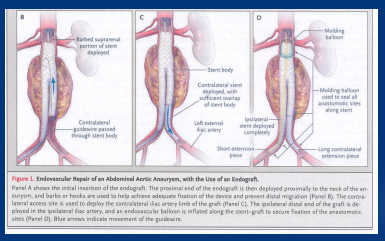
UpToDate

Endovascular Repair of AAA

At present, EVR accounts for > 60% of all repairs

Operative mortality associated with EVR only 1/3 that of 0pen repair

Early benefit of EVR lost in the longer term



N ENGL J MED Vol 358, January 31, 2008

After 4 years, aneurysm-related mortality significantly higher in EVR

Risk extends out at least 8 years Re-intervention after EVR remains a substantial risk after 4 years

Case 7: Relative Mortality Risk?

65-year-old mechanical engineer with statin-treated hyperlipidemia and well-controlled hypertension. In May 2010 due to non-specific abdominal pain he had an abdominal ultrasound that showed an abdominal aorta of 4.3 cm

(a) Scenario
May 2012 abdominal ultrasound reveals AAA 4.3 cm

(b) Scenario
Same as (a) except that AAA size is 4.6 cm

Relative Mortality

- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 8

45-year old male

Background:

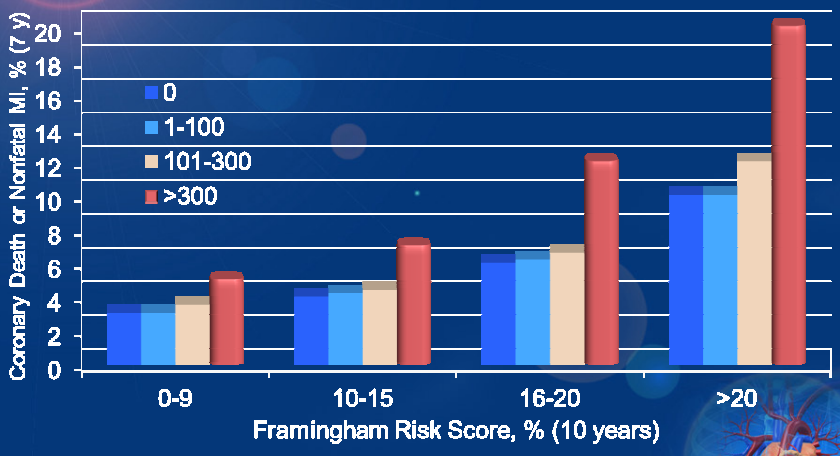
Family History of premature CAD with MI & death in 50s: paternal grandfather, maternal grandfather, maternal aunt, maternal uncle.

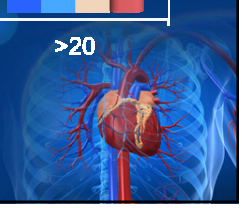
Treated and well controlled hyperlipidemia. Borderline normal BP, 5'9" 179#, asymptomatic and runs for exercise.

Had EBCT and "positive" calcium score, but we do not have results. This was followed by a CCTA for "coronary artery disease" on 7/6/09

ETT 7/20/09: 12:00, 13 METS, HR to 172 and reported as EKG negative and normal Echocardiogram response to exercise.

Coronary Artery Calcium Scores at Various Framingham Risk Score Thresholds





Case 8 . . . Cont.

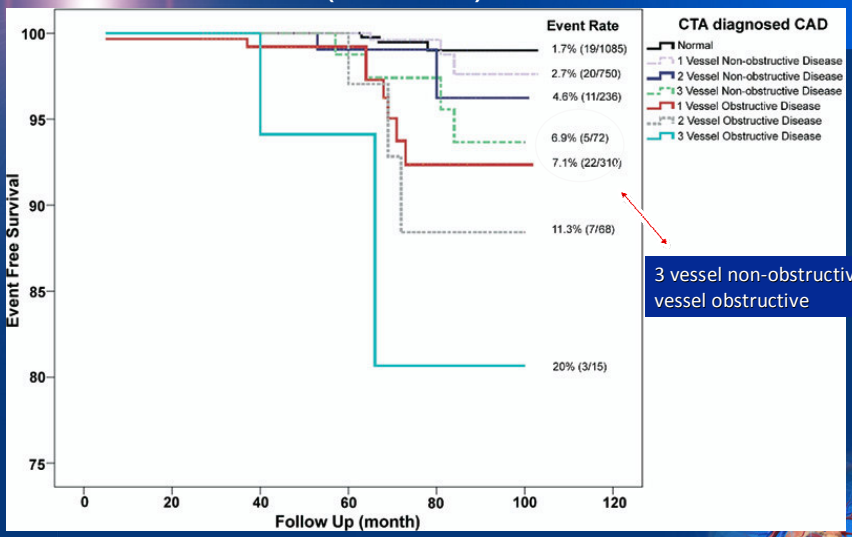
Same 45-year-old male

CTA 2009:

There is diffuse calcified plaque throughout the proximal and mid-LAD with two potential areas of flow limiting stenosis.

Mild calcified plaque is present in the proximal and mid-left circumflex artery as well as the proximal and mid RCA without significant coronary artery stenosis

Silent Lesions (< 50%)

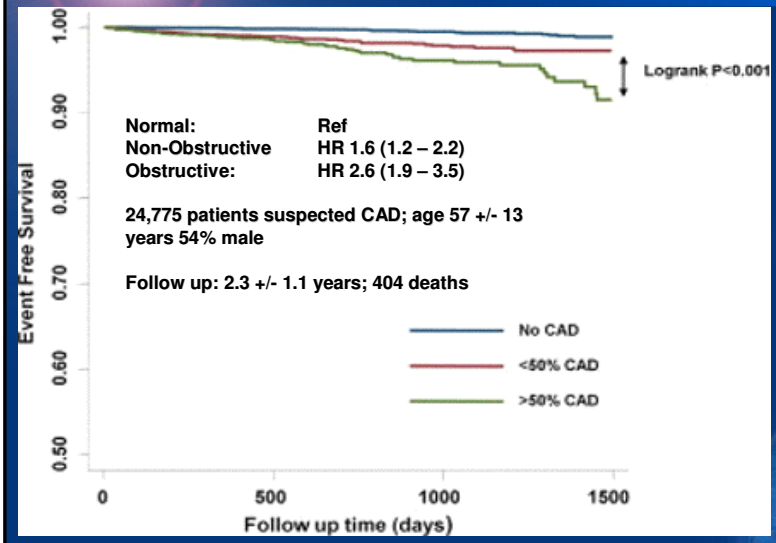


3 vessel non-obstructive = 1 vessel obstructive

The burden of angiographic disease detected by CTA provides both independent and incremental value in predicting all-cause mortality

JACC 2008

Silent Lesions (< 50%)



Normal: **Ref**
Non-Obstructive **HR 1.6 (1.2 – 2.2)**
Obstructive: **HR 2.6 (1.9 – 3.5)**

24,775 patients suspected CAD; age 57 +/- 13 years 54% male

Follow up: 2.3 +/- 1.1 years; 404 deaths

10,146
8,114
5,594

Coronary Angiography Prognosis

CONFIRM JACC 2011

Case 8: Relative Mortality Risk?

45 y/o with family history of premature CAD with MI & death in 50s: paternal grandfather, maternal grandfather, maternal aunt, maternal uncle.

Treated and well controlled hyperlipidemia. Borderline normal BP, 5'9" 179#, asymptomatic and runs for exercise.

Had EBCT and "positive" calcium score, but we do not have results. This was followed by a CCTA for "coronary artery disease" on 7/6/09

ETT 7/20/09: 12:00, 13 METS, HR to 172 and reported as EKG negative and normal Echocardiogram response to exercise.

CTA 2009: diffuse calcified plaque throughout the proximal and mid-LAD with two potential areas of flow limiting stenosis.

Mild calcified plaque is present in the proximal and mid-left circumflex artery as well as the proximal and mid RCA without significant coronary artery stenosis

Relative Mortality

- **100 %**
- **150 %**
- **200 %**
- **250 %**
- **300 %**
- **300 %+**

Case 9

60-year-old female with hypertension and chronic microalbuminuria with negative renal workup. Also sleep apnea surgery

EBCT February 2008 Zero

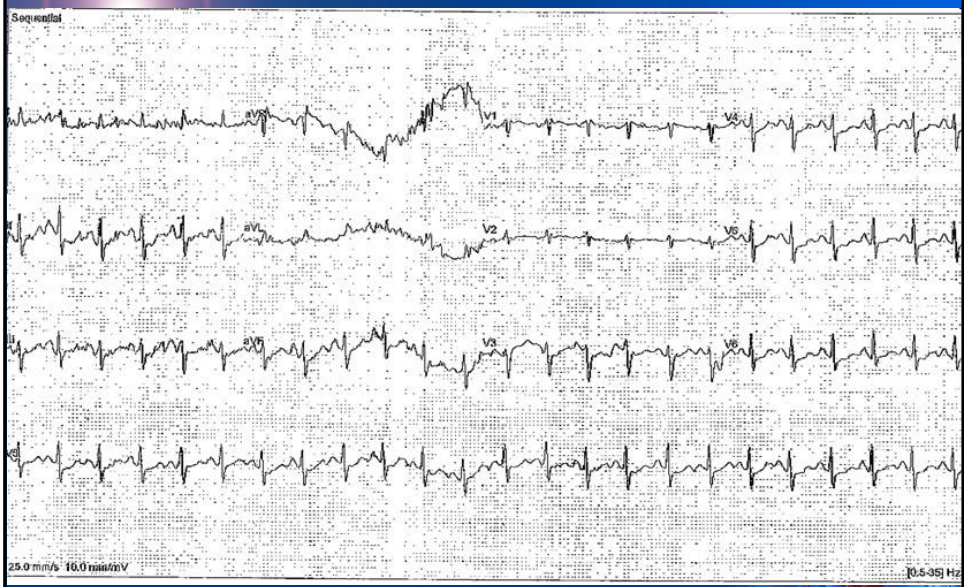
Echocardiogram 2008 normal

Cooper Clinic stress test February 2008: negative; no PVCs (report)

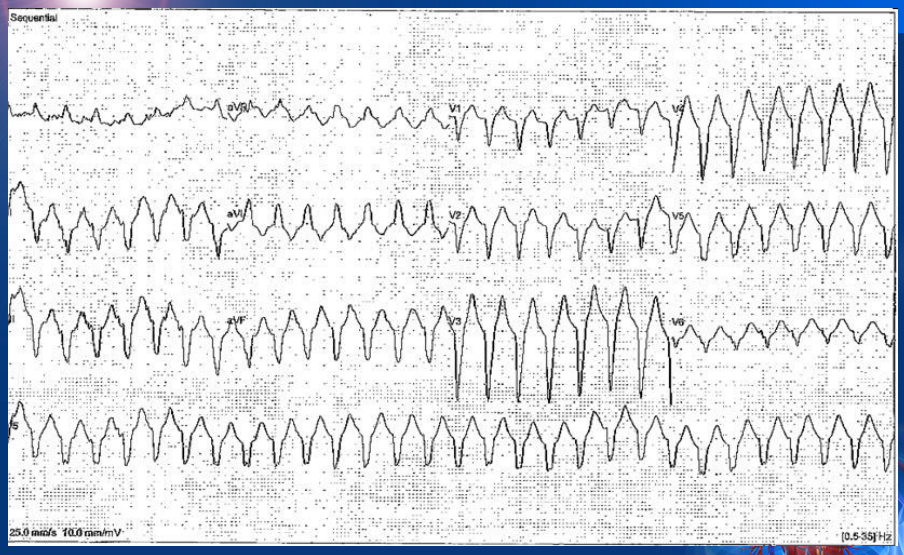
Jan 2011 stress test: rsr' pattern in V1-2; negative for ischemia no PVCs (Balke Protocol)

Dec 2011 - Stress test done as part of insurance physical

Case 9



Case 9



Slide 77

EDITORIAL COMMENT

The Cardiologists' Worst Nightmare

Sudden Death From "Benign" Ventricular Arrhythmias*

And… The Medical Director Worst Nightmare

"Benign" Arrhythmias that kill

Type of VT	QRS morphology/axis	Pharmacoterapy sensitivity	Treatment
RVOT VT/ monomorphic extrasystoles	LBBB/ inferior axis	Adenosine, B-blocker, verapamil (or diltiazem) B-Blocker, verapamil	RF ablation
LVOT VT	S wave in lead I, R-wave transition in V1 or V2	Adenosine, B-blocker, verapamil (or diltiazem) B-Blocker, verapamil,	RF ablation
Fascicular VT	RBBB/ left superior axis (exit posterior fascicle); RBBB/right inferior axis (exit anterior fascicle)	Verapamil	RF ablation

Case 9: Relative Mortality Risk?

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Relative Mortality

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Case 10

61 year-old male, 5'6" 272 pounds, with stable angina. Diabetes ten years treated with insulin (HbA1c between 7.5 – 8%). In 2007 right common femoral artery stented for PAD.

2010 : Angina with positive stress test
New Cath:

RCA: 100% obstructed
LAD: proximal stent is patent
First diagonal: moderate ostial obstruction
Circumflex: proximal stent patent
OM1 50 %; OM2 99%

"The angina may be possibly due to his chronic total occlusion – insufficient collateral's to RCA". Treated with long acting nitrates

Case 10 . . . Cont.

December 2011: leg ulceration (Severe PAD?)

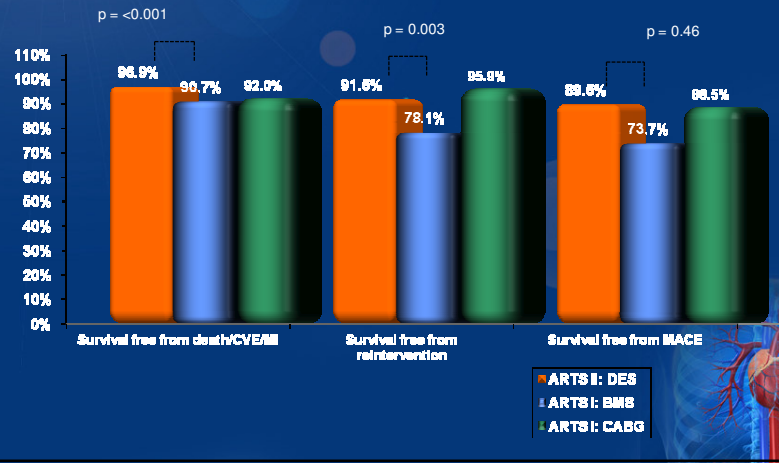
APS: last office visit March 2012 (one page)
"The patient has recent recurrence of chest pain"

SPECT Study – 7 minutes modified Bruce protocol (METS ?)
Resting EF 45% - no significant wall motion abnormality
No evidence of exercise induced ischemia

Slide 81

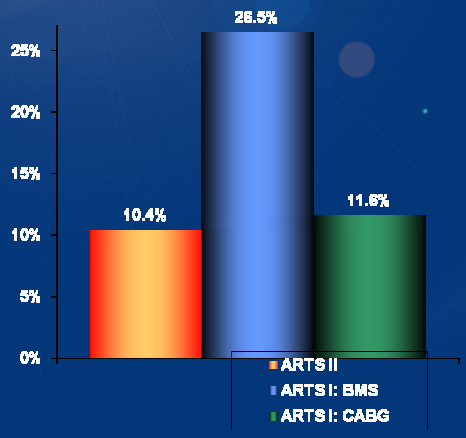
ARTS II: Event free survival

At one year, there was no difference in event-free survival between the ARTS II SES group and the ARTS I CABG group. However, the ARTS II group showed significantly higher rates of survival free from cardiac death, MI, and reintervention than the ARTS I bare metal stent group. The groups were not significantly different in the primary endpoint of survival free from MACCE.



ARTS II: MACCE at one year

Overall MACCE at 1 year



- At 1 year, there was no difference in the incidence of MACCE between the ARTS II SES group and the ARTS I CABG group.
- The ARTS I bare metal stent group was associated with a significantly higher rate of 1 year MACCE compared to the other groups

PTCA Fallacy #1

Fallacy

"Doc said I had a 90% blockage. Thank goodness he fixed it in time and saved my life"

Facts

- There is no such thing as a 90% stenosis
- Even if there were, in most cases PTCA is not a life-saving intervention

PTCA Fallacy #2

Fallacy

"Mr. Jones had severe 2-vessel disease but really didn't want a bypass operation, so I stented both vessels"

Facts

- PTCA is often the first step on the road to CABG
- If a patient really wants to avoid CABG at all costs, medical therapy is the way to go

The COURAGE Paradigm

PTCA Fallacy #3

Fallacy

"For most patients with multi-vessel disease, PTCA can provide comparable long-term survival benefits and quality of life as bypass surgery"

Facts

- The randomized trials of PCI vs. CABG have included only highly selected patients
- Observational data still suggest improved survival with CABG in severe multivessel disease

The COURAGE Paradigm

PTCA Fallacy #4

Fallacy

An asymptomatic patient with an abnormal ETT is at high risk for short term complications

"Thankfully, doc ordered that screening stress test when I turned 50 and that other nice doctor did an angioplasty the next day. I could have had a heart attack!"

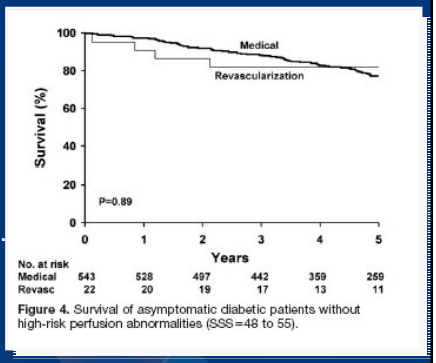


Figure 4. Survival of asymptomatic diabetic patients without high-risk perfusion abnormalities (SSS=48 to 55).

Facts

- The benefit of revascularization in asymptomatic patients (even our high-risk diabetic patients) is likely restricted to those with high risk stress test findings.
- Risk of periprocedural MI approximates annual risk in some cases

Sorraja P. Circulation. 2005; 112: I311

PTCA Fallacy #5

Fallacy

Stable Angina means the patient needs revascularization to prevent a heart attack

"Thankfully, doc sent me to the hospital for those chest pains and that other nice doctor did an angioplasty the next day. I could have had a heart attack!"

Facts

- PTCA reduces symptoms in chronic angina and may increase the risk of MI, or needing a CABG

Sorraja P. Circulation. 2005; 112: I311

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