The aortic valve: impedance, misfits and bulges

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A new way to look at the aortic valve

- Aortic stenosis patients with the same gradient (and valve area) aren't all the same
- We can now predict which patients with AS are destined to have a worse prognosis

Let's consider 2 patients each with a gradient of 80 mmHg.

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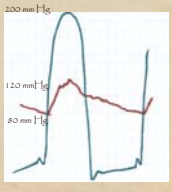

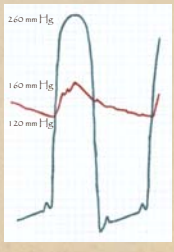

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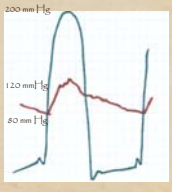

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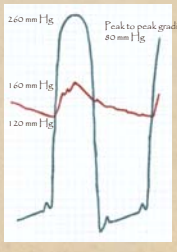

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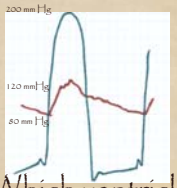

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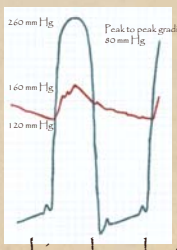

Which ventricle is working harder???

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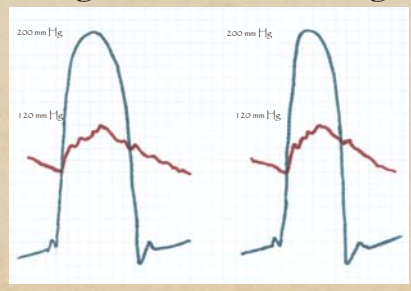

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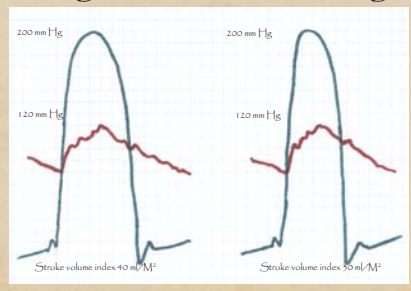

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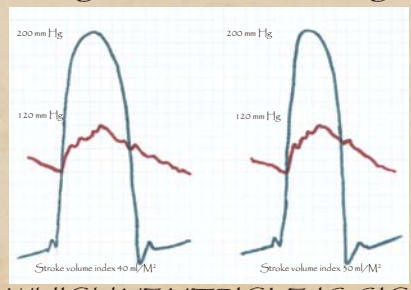

WHICH VENTRICLE IS SICKER???

Leveling the playing field

To assess how hard the ventricle is working:
- Add the gradient to the systolic BP

To determine how healthy the ventricle is:
- Calculate the stroke volume index from the measured 2 plane LVEF and LV volume.

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- Divide the sum of BP + mean gradient by the stroke volume index

Z = BP + grad/ SVI. Normal < 3.5

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Divide the sum of BP + mean gradient by the stroke volume index

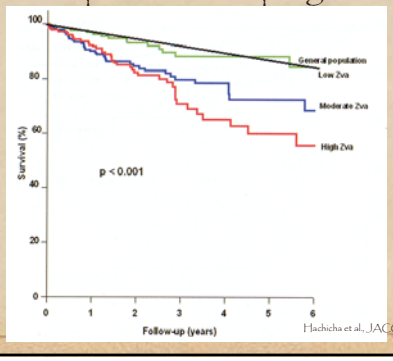
Z = BP + mean grad/ SVI. Normal < 3.5

Aortic impedance and prognosis

- Quebec Heart & Lung Institute, 544 Asymptomatic patients with mod AS, jet velocity > 2.5 m/s
- Four year survival
  - Z > 4.5 65 +/- 5%
  - Z 3.5 – 4.5 78 +/- 4%
  - Z < 3.5 88 +/- 3%

Hachicha et al., JACC 2009; 54: 1003-11

Aortic impedance and prognosis



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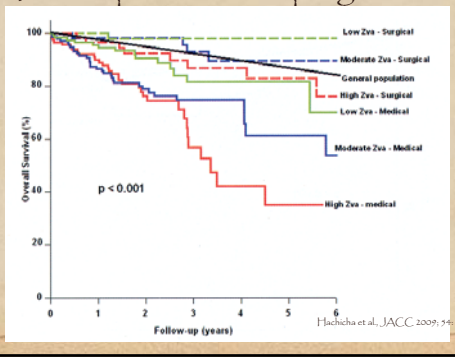

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Aortic impedance: implications

- There may be a paradoxical patient with low gradient severe AS with normal EF.
- These patients are more likely to be elderly women with advanced disease.
- Unlike the gradient itself, the Z score can be modified to some degree – control blood pressure, improve stroke volume.

Aortic impedance: implications

- With this Z score classification, all patient groups did better with surgery than with medical therapy.
- Using the gradient alone to classify patients misses important physiological characteristics.
- When the gradient and valve area are discordant, out of habit, I bet most of us use the gradient rather than valve area.

Aortic impedance: implications

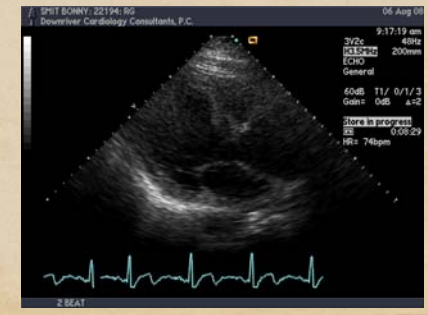
- The ease with which the Z score is implemented in a busy lab depends on how echoes are done prior to that point: routine recording of BP, routine measurement of 2 plane LVEF.

Here's something you don't find every day....

"My doctor examines me on every visit. He heard a new murmur."

About this patient...

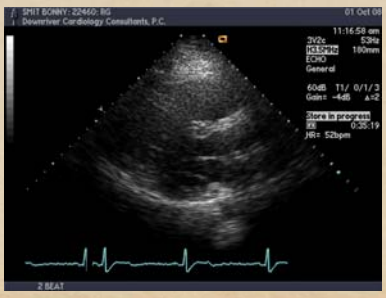
- 33 year old female
- 5'7", 280 lbs. BP 170/60
- BSA 2.3 m^2



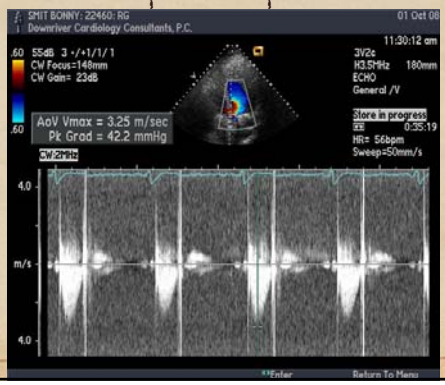
One week later the patient had aortic valve replacement

27 mm St. Jude valve with a 33 mm Dacron valve conduit and re-implantation of the coronary arteries.

Uneventful surgery and recovery



First post-op echo



Post-op echo measurements

- Peak gradient 42 mm Hg
- Mean gradient 24 mm Hg
- Calculated valve area 1.44 cm^2
- Dimensionless index 0.46

Patient-prosthesis mismatch

- The effective orifice area is less than that of a normal human valve, expressed in terms of valve index:
- Not significant > .85 cm^2/m^2
  Moderate > .65 to < .86 cm^2/m^2
  Severe < .66 cm^2/m^2

And more about the valve...

- St. Jude 27 mm valve: a bi-leaflet tilting disc valve.
- Effective orifice area: 2.5 cm^2
- Threshold for patient-prosthesis mismatch
  - Mild .85 x 2.3 = 2.0 cm^2
  - Severe .65 x 2.3 = 1.5 cm^2
- Calculated value for patient = 1.44 cm^2

Patient status, 10/12/09

- Feels great! No shortness of breath.
- The effect of patient prosthesis mismatch may be less pronounced for patients with BMI > 30 compared to patients with similar BSA.
- (CCF series of 1,000 patients: no clinical consequence of PPM.)

A tale of two biddies

Patient LS. AVR 1996, 19 mm Hancock

- 1996 peak 44 mean 20
- 2000 52 26
- 2009 62 36

Patient RT. AVR 1992, 21 mm SJM

- 1997 peak 29 mean 19
- 2002 46 26
- 2007 78 38

Patient prosthesis mismatch

- Not significant > .85 cm^2/m^2
  Moderate > .65 to < .86 cm^2/m^2
  Severe < .66 cm^2/m^2
- ***Survival at*** ***5 years*** ***8 years***
  Not significant 85% 74%
  Moderate 80% 65%
  Severe 72% 41%

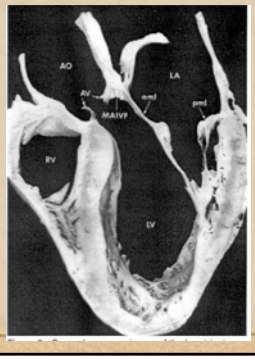
Patient-prosthesis mismatch

- Greatest clinical impact on patients with low EF at the time of surgery
- Should be considered as a mechanism for lack of functional recovery after AVR.

Pseudoaneurysm of the mitral-aortic intervalvular fibrosa

- A rare and serious complication after AVR or composite graft surgery for combined disorders of the aortic root and valve

Necropsy specimen



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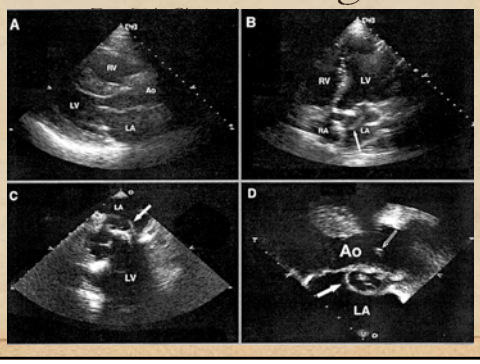
Four echo images



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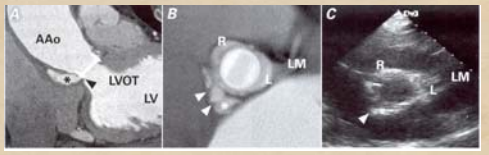
Patient number one

A patient from Texas Heart



Tsai et al, Tex Heart Inst J. 2009; 36 (5): 428-32

Patient number 2: woulda, coulda, shoulda

Pseudoaneurysm of the MAIVF: implcations

- This rare complication is most often diagnosed by CT, but most clinicians aren't looking for it.
- The natural history of this is not defined.
- It may be diagnosed in the OR, when corrective surgery could be easily done.

Summary

- An approach to the whole patient is the best bet with severe AS– that means going beyond the gradient and valve area as sole descriptors of the condition.
- By calculating the BSA pre-op, the echocardiographer can tell the surgeon the minimum acceptable orifice area for aortic valve replacement.
- Pseudoaneurysm of the intervalvular annulus fibrosa is rare, but might be effectively treated in the OR.