Valvular Disease: Aortic valve stenosis and regurgitation

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Aortic valve disease

- Rapidly changing landscape with
  - New valvular heart disease guidelines in 2014
  - Transcatheter aortic valve replacement
  - Catheter-based strategies for managing prosthetic valve dysfunction
2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease:
A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines


http://content.onlinejacc.org/article.aspx?articleid=1838843
Severe aortic valve stenosis

- In the setting of preserved cardiac output:
  - Peak systolic velocity ≥ 4 m/sec
  - Mean systolic gradient ≥ 40 mmHg
  - Valve area <1 cm²

- Echocardiography primary means of assessing

- Cardiac catheterization in selected cases
Severe aortic valve stenosis: challenging situations

- With depressed cardiac output (low flow, low gradient AS)
  - Velocity and gradient low relative to valve area
  - Dobutamine echocardiogram may help
- Paradoxical low gradient AS
  - Normal cardiac output, but gradient low relative to valve area
Prevalence of moderate-severe aortic valve stenosis by age in Olmsted County

Prevalence of aortic valve stenosis by age in Tromsø, Norway

The changing demographics of the USA

Millions

- 1960
- 2010
51 year old commercial pilot

- Noted to have murmur on entry to Air Force ROTC
  - Evaluation ‘negative’
  - Flew fighter jets
- Has had slowly progressive exertional dyspnea for several years
  - No other cardiac symptoms
  - Otherwise healthy
51 year old commercial pilot

Echocardiogram:

- Severe aortic valve stenosis
  - Aortic valve area 1.0 cm$^2$
  - Mean systolic gradient 53 mmHg
- Normal left ventricular size and wall thickness
- Ejection fraction 65%

Normal coronary angiogram
51 year old commercial pilot
What is his prognosis without operation?

1. Median event free survival 6 months
2. Median event free survival 1 year
3. Median event free survival 2 years
4. Median event free survival 4 years
5. Median event free survival 8 years
Aortic valve replacement by morphology

Natural history of bicuspid aortic valve

- Asymptomatic patients with bicuspid aortic valve and no or mild AS/AR
  - 20-year survival identical to general population
  - 20 year events:
    - HF 7%
    - CV symptoms 26%
    - AVR (majority for AS): 24%
    - Ascending aorta repair 5%
      - No dissection in 212 patients

Natural history of bicuspid valve associated aortopathy

• Progressive ascending aorta enlargement seen in many but not all patients with bicuspid AV

• Low risk of dissection relative to other heritable aortopathies, but increases with diameter
  • Primary aortic repair when 5 cm or greater
  • Concomitant repair with AVR when 4.5 cm or greater

Natural history of unoperated severe aortic valve stenosis

- Ross and Braunwald (1968): Symptomatic AS
  - 5-year survival 35%, 10-year 10%.
  - Risk with HF (2 yr) > syncope (3 yr) > angina (5 yr median survival)
  - More than half of deaths were ‘sudden’

- Varadarajan, et al (2006): Severe AS (AVA ≤ 0.8 cm²)
  - 1-year survival 62%, 5-year 32%, 10-year 18%

Ross and Braunwald. Circulation. 1968; 38(s5):61-67
Natural history of aortic valve stenosis

  - Event free survival: 1 year 93%, 2 years 74%
  - 38% had symptoms at 2 years
  - 3% cardiac death (2 sudden all symptomatic)
  - Event free survival: 1 year 64%, 2 years 36%, 3 years 25%, 4 years 12%, 6 years 3%.
  - 6% cardiac deaths (2 sudden: 1 symptomatic)

Survival without valve replacement and with TAVR from Partner trial

51 year old commercial pilot
What would you recommend?

1. Echocardiographic and clinical follow-up in 6 months
2. Echocardiographic and clinical follow-up in 12 months
3. Surgical aortic valve replacement with tissue prosthesis
4. Surgical aortic valve replacement with mechanical prosthesis
5. Transcatheter aortic valve replacement
Guidelines recommend AVR when

- Class I
  - Severe symptomatic AS
  - Severe asymptomatic AS with EF <50%
  - Severe asymptomatic AS with other cardiac surgery
• Class IIa
  • Very severe (velocity >5 m/sec, mean gradient >50 mmHg) asymptomatic AS
  • Severe asymptomatic AS with abnormal stress test
  • Symptomatic patients with valve area <1 cm$^2$; low EF; and low flow, low gradient AS
  • Symptomatic patients with valve area <1 cm$^2$; low flow, low gradient AS; and normal EF if no other cause of symptoms found
  • Asymptomatic patients with moderate aortic stenosis undergoing cardiac surgery
Follow-up echocardiogram recommendations

- Mild AS: 3-5 years
- Moderate AS: 1-2 years
- Severe, asymptomatic AS: 6 - 12 months
51 year old commercial pilot

- Underwent aortic valve replacement with 27 mm Carpentier Edwards Perimount tissue prosthesis
  - Found to have bicuspid aortic valve
  - Post-operative atrial fibrillation: resolved
- Feeling well at 6 month follow-up
  - Echo: normal left ventricle, normal prosthesis
  - Holter: rare SVPCs, no atrial fibrillation
- Resumed flying
Surgical valve prostheses

- Ball cage
- Tilting disc
- Bovine
- Porcine
- Porcine stentless
Cardiac surgical risk with age

Society of Thoracic Surgeons (STS) Score

http://riskcalc.sts.org/stswebriskcalc/#!

Procedure Type

- CAB Only
- AV Replacement
- MV Replacement Only
- MV Repair
- AV Replacement + CAB
- MV Replacement + CAB
- MV Repair + CAB

Patient Age: 50

Sex:
- Male
- Female

Risk of Mortality: 1.966%
Morbidity or Mortality: 13.677%
Long Length of Stay: 6.341%
Short Length of Stay: 34.499%
Permanent Stroke: 1.565%
Prolonged Ventilation: 5.339%
DSW Infection: 0.190%
Renal Failure: 2.213%
Reoperation: 7.567%
Indications for TAVR

• Severe aortic valve stenosis
• Moderate or high surgical risk: STS ≥3 (Sapien)
• High surgical risk: STS ≥8 (CoreValve)
• Tricuspid aortic valve morphology
  • Not for bicuspid aortic valve
• Appropriate aortic annulus and aortic root dimensions
• Not for primary aortic regurgitation
Transcatheter valve prostheses

Edwards Sapien 3 (bovine)

Medtronic CoreValve Evolut (porcine)
TAVR implantation

- Transfemoral (preferred)
- Transapical
- Transaortic

Modified from https://upload.wikimedia.org/wikipedia/commons/6/6b/Man_shadow_with_organs.png
Results of PARTNER trial for non-operative patients

Results of PARTNER trial for non-operative patients

Results of PARTNER trial for high risk patients

A. Death from Any Cause, All Patients

- Hazard ratio, 0.93 (95% CI, 0.71–1.22)
- P = 0.62

No. at Risk
Transcatheter: 348, 298, 260, 147, 67
Surgical: 351, 252, 236, 139, 65

B. Death from Any Cause, Transfemoral-Placement Cohort

- Hazard ratio, 0.83 (95% CI, 0.60–1.15)
- P = 0.25

No. at Risk
Transcatheter: 244, 215, 188, 119, 59
Surgical: 248, 180, 168, 109, 56

C. Death from Any Cause, Transapical-Placement Cohort

- Hazard ratio, 1.22 (95% CI, 0.75–1.98)
- P = 0.41

No. at Risk
Transcatheter: 104, 83, 72, 28, 8
Surgical: 103, 72, 68, 30, 9

D. Death from Any Cause or Major Stroke

- Hazard ratio, 0.95 (95% CI, 0.73–1.23)
- P = 0.70

No. at Risk
Transcatheter: 348, 289, 252, 143, 65
Surgical: 351, 247, 232, 138, 63
Results of PARTNER trial for high risk patients

TAVR for moderate risk (STS ≥4) patients

TAVR vs Surgical AVR

• Favors TAVR:
  • Mortality in high risk patients (trans-femoral only)
  • MI, major bleeding, AKI, new atrial fibrillation

• Favors SAVR
  • PM implantation, vascular complications, paravalvular regurgitation
    • Paravalvular regurgitation > mild increases mortality

TAVR valve hemodynamics: Partner I trial

‘Natural history’ of tissue prosthesis

- Increased risk of valve degeneration after 10 yrs
  - Risk greater with younger patients
- Risk of thromboembolic complications low (0.7%/year)
  - No routine use of anticoagulants after first several months
  - Aspirin recommended
  - Small risk of late thrombotic obstruction
- SBE prophylaxis recommended
- Echo with change in exam or symptoms or after 10 years
Frailty affects mortality after TAVR

- Multidimensional Geriatric Assessment
  - Cognition, nutrition, ADLs, mobility
- Ability to predict mortality and major adverse cardiac and cerebrovascular events similar to and independent of STS score
- Identifies patients with diminished physiologic reserves
- No clear cutoff as to when ‘too frail’ for TAVR

Frailty assessment used in our Valve Clinic

• 5m gait speed
• Grip strength
• Serum albumin
• ADLs
Early and late mortality after TAVR

- **30-day mortality**
  - Home oxygen use
  - Albumin <3.3 mg/dl
  - Assisted living
  - Age >85

- **1-year mortality**
  - Home oxygen use
  - Albumin <3.3 mg/dl
  - Falls in the last 6 months
  - High Charlson comorbidity score ≥5
  - STS risk of mortality >7%

Valve-in-valve ‘re-operation’

- Option for failed tissue prostheses in high risk patients
  - Some degradation in orifice area
    - Higher gradient
    - Better in 23 mm or larger prostheses
  - Not for mechanical prostheses
- Many patients ‘banking’ on this option when deciding valve type
Future directions for TAVR

• Bicuspid aortic valve
  • 301 patients with bicuspid valve in Bicuspid TAVR Registry
    • ‘Old’: Sapien XT (87); CoreValve (112)
    • ‘New’: Sapien 3 (91); Lotus (11)
  • Success better with ‘new’ valves (92.2% vs 80.9%) mostly due to absence of significant periprosthetic regurgitation

• Primary aortic valve regurgitation?

43 year old aerial applicator

- Had been found to have a bicuspid valve with significant aortic valve regurgitation 10 years prior
  - Lost to cardiology follow-up
  - FAA ‘recommended’ cardiology evaluation
- Asymptomatic
- Active pilot
43 year old aerial applicator

Echocardiogram:
- Bicuspid aortic valve
- Severe aortic valve regurgitation
- Severe left ventricular enlargement
  - 79 mm diameter at end-diastole
  - 45 mm diameter at end-systole
- Normal ejection fraction: 70%
- Borderline ascending aorta dilatation
43 year old aerial applicator
What is his prognosis?

1. Median event free survival 6 months
2. Median event free survival 1 year
3. Median event free survival 2 years
4. Median event free survival 4 years
5. Median event free survival 8 years
Severe aortic valve regurgitation

• Regurgitant volume ≥60 ml
• Regurgitant effective orifice ≥0.3 cm²
• Regurgitant fraction ≥50%
• Angiography: grade III or IV regurgitation

• Diagnosis of chronic severe AR requires LV dilatation
Natural history of chronic aortic valve regurgitation

• Prolonged period of asymptomatic compensation
  • Low risk of sudden death
  • Symptoms and/or need for surgery develop in about 4%/year
• Routine monitoring of LV size and function
• Profound ventricular enlargement or systolic dysfunction often precede symptoms
• Symptomatic regurgitation portends poor prognosis
43 year old aerial applicator
What would you recommend?

1. Echocardiographic and clinical follow-up in 6 months
2. Echocardiographic and clinical follow-up in 12 months
3. Surgical aortic valve replacement with tissue prosthesis
4. Surgical aortic valve replacement with mechanical prosthesis
5. Transcatheter aortic valve replacement
Guidelines recommend AVR when

- **Class I**
  - Severe symptomatic AR
  - Severe asymptomatic AR with systolic dysfunction (EF <50%)
  - Severe AR undergoing other cardiac surgery

- **Class IIa**
  - Severe asymptomatic AR with severe LV dilatation (LVESD >50 mm or 25 mm/m²)
  - Moderate AR undergoing other cardiac surgery
• Class IIb
  • Severe AR with progressive severe LV dilatation (LVEDD >65 mm)
43 year old aerial applicator

- Underwent aortic valve replacement with a 25 mm St Jude Silzone mechanical prosthesis
- Asymptomatic at 6 months follow-up
  - Echocardiogram: normal LV size, ejection fraction 60%, normal prosthetic function, mild-moderate periprosthetic regurgitation
  - Stress test: negative with good exercise capacity
  - Holter: no arrhythmias
- Allowed to return to flying 8 months after surgery
Now 60 year old aerial applicator

- Still asymptomatic
- Echocardiograms essentially unchanged
- Still flying
‘Natural history’ of mechanical prosthesis

• Very low risk of mechanical failure
• Require anticoagulation
  • Risk of acute thrombosis
    • 0.5% per patient-year
• Long-term risk of pannus formation
• Risk of endocarditis
  • SBE prophylaxis
• Echo with change in exam or symptoms
Anticoagulation for mechanical prostheses

• Direct oral anticoagulants contraindicated
• Bileaflet or current-generation of tilting disc
  • Warfarin with goal INR 2.5
  • No bridging required
• High risk or older generation valves
  • Warfarin with goal INR 3.0
  • Bridging required for procedures
• Consider aspirin 81 mg for all prostheses
What if the periprosthetic aortic valve regurgitation had been worse?

• Reoperation
  • Carries somewhat increased risk (roughly double the original surgical risk)
  • Occasionally anatomy or tissue characteristic result in recurrence of defect

• Percutaneous ‘peri-leak’ closure
  • “Plug” placed via catheter approach
  • Appropriate for high risk patients with suitable anatomy
  • Limited access, evolving technology
Summary

• Risk of sudden death greater for severe aortic valve stenosis than for severe aortic valve regurgitation

• Outcomes after aortic valve replacement good

• Role of TAVR evolving, more patients eligible
  • Currently only for degenerative AS or prior bioprosthetic dysfunction

• DOACs contraindicated for mechanical prostheses