Aortic Valve Pathology and Treatment
Valvular Aortic Stenosis in Adults
Average Course
(Post mortem data)

Percent survival

Latent period
(Increasing obstruction, myocardial overload)

Onset severe symptoms

Angina
Syncope
Failure

Average survival, years

Average age death (♂)

Age (years)

Circulation 38 (Suppl. 5) 61, 1968
Medically Treated Valvular Disease

Average Course (Survival)

Rappaport E: Am J Cardiol 35:221, 1975
Valve Surgery

- Represents a growing public health problem!

- Growth
  - over 10 years
  - (1992-2001)
Valve Anatomy

- 4 Valves
  - Semilunar
    - Pulmonic
    - Aortic
  - Atrioventricular
    - Tricuspid
    - Mitral
Aortic Valve

- Normal Valve
- 3 Leaflets
  - Right Coronary
  - Noncoronary
  - Left Coronary
- Cross-sectional area of about 3 cm sq
Aortic Valve

- Conduction system
- Anterior leaflet mitral valve
 Diagnostic Approach

- Clinical findings
  - Exam
  - Murmur
- Chest X-Ray
- ECG
- Imaging
  - Echocardiography
  - Angiography
  - MRI
As ventricular pressure (---) increases and exceeds atrial pressure (---)
- atrioventricular valves close
- causing the S1 heart sound
Aortic pressure (red) exceeds Ventricular pressure (blue) – the semilunar valves close, causing the S2 heart sound.
Transesophageal Echo

LV short axis
Papillary view
Transesophageal Echo

LV short axis mitral view
Cardiac Catheterization

Left Coronary

Right coronary
MRI

The Future

Aortic Regurgitation

Trileaflet Pulmonary Valve

Bileaflet Pulmonary Valve
Aortic Valve

- Stenosis
- Regurgitation
Preoperative Data: AVR

Valvular Lesion

- Insufficiency: 13%
- Mixed: 22%
- Stenosis: 65%

NYHA Class

- Class I: 2%
- Class II: 28%
- Class III: 57%
- Class IV: 13%

% of Patients
Aortic Stenosis
Disease of the Elderly
Symptoms begin:
60-80 yrs. of age
Causes:
Scarring
Calcification
Rheumatic fever
Bicuspid valve
Aortic Stenosis
Pathophysiology

- Increased resistance to blood flow from the left ventricle to the aorta
  - Increased work
  - Left ventricular hypertrophy
    - Smaller ventricular cavity
  - Increased oxygen demand
    - Can lead to ischemia
      - Heart failure
Aortic Stenosis
Symptoms

- Chest pain (angina)
  - occurs during exertion
  - blood supply to the enlarged heart muscle is inadequate
- Heart failure develops
  - fatigue
  - shortness of breath during exertion
- Syncope
  - Exertion leads to peripheral arterial vasodilatation
  - AS limits cardiac output preventing compensation
- Sudden Death
Aortic Stenosis Diagnosis

- **Physical Examination**
  - Heart Murmur
    - Heard over aortic area
    - 2nd right intercostal border
    - Midsystolic murmur
    - Radiates down left sternal border

- **ECG**
  - Left ventricular hypertrophy
Aortic Stenosis
Chest X-ray

Prominent left ventricle
Aortic Stenosis
Diagnosis

Echocardiography
Cardiac Cath
>45 years

Short Axis ↑
Long Axis →
Aortic Stenosis Treatment

- **Asymptomatic**
  - Regular follow-up
  - Serial Echo

- **Symptomatic**
  - Aortic valve area less than 1.2 cm$^2$/M$^2$
    - Severe Aortic Stenosis
      - Valve area $\leq$1 cm$^2$
      - Mean Gradient >40 mm Hg (normal LV)

- **Medical Therapy**
  - Diuretics

- **Surgical replacement**
  - before irreversible damage
Aortic Stenosis Survival

- Symptomatic Surgery vs Medical

NEJM, Carabello 346 (9): 677  
February 28, 2002
Aortic Regurgitation

- Increasing volume and pressure in the left ventricle
  - Result:
    - Increased work
    - Ventricles thicken to compensate
    - Hypertrophy
    - Chambers dilate
    - Eventually CHF
Aortic Regurgitation

- Rheumatic Fever
  - Historical cause
- myxomatous degeneration
- aortic aneurysms & dissection
- bicuspid valve
- infective endocarditis
Aortic Regurgitation Symptoms

- **Mild**
  - Asymptomatic heart murmur

- **Severe**
  - Palpitations
    - LVH
  - Congestive heart failure
    - Shortness of breath
    - Fatigue
    - Angina
      - Reduce SBP during ventricular diastole
      - Wide pulse pressure
Aortic Regurgitation

◆ Physical exam
  - Murmur
    ◆ Heard with diaphragm
    ◆ Midsystolic

◆ ECG:
  - LVH

◆ Chest X-ray
  - cardiomegaly
Aortic Regurgitation

- Echo

- Cardiac Cath
  - 20% of people with aortic regurgitation also have coronary artery disease
Aortic Regurgitation Treatment

- **Mild**
  - Medical management
    - Digoxin, Diuretics
    - Calcium channel blocker
    - Ace

- **Moderate to severe:**
  - Surgery

- **Cardiac Cath**
  - 20% of people with aortic regurgitation also have coronary artery disease
Aortic Valve Replacement
Possible Prostheses

- Mechanicals valves
- Homografts
- Engineered Tissue Valves
  - Stented (porcine or bovine)
  - Stentless (porcine)
- Pulmonary Autograft
- Aortic Remodeling
Mechanical Valve Products

- SJM Regent™ valve (bileaflet)
- Carbomedics Standard bileaflet valve
- Medtronic – Hall™ tilting disc valve
Tissue Valve Products

**Stented Valve**
- Edwards Lifesciences
- Carpentier - Edwards Perimount™ valve

**Stentless**
- St. Jude Medical
- Toronto SPV® valve

**Homograft**
- LifeNet
- Homograft
Stentless Aortic Valves

- Modeled after native aortic valve
- Eliminates residual stenosis caused by stents
- Near-normal hemodynamics
- Normalizes LV mass and performance
Stentless Porcine Valves

Toronto SPV® Valve

Freestyle® Valve
Sutureless Aortic Valves
Percutaneous Aortic Valves
Stented Aortic Valves

- Obstructive to flow
- Decreased effective orifice areas
- Increased transvalvular pressure gradients
- Residual left ventricular hypertrophy
- Calcification at stent/tissue interfaces
- Rigid, non-compliant with aorta
Aortic Root Reconstruction

- Aortic Root Replacement
- Coronary Reimplantation
Aortic Root Remodeling

- Aortic valve preservation
- Remodeling of root geometry
- Coronary Reimplantation
Echo

Stentless Freestyle Bioprosthesis
Natural Valve
Valve Surgery Trends

Durability

Anticoagulation

Lim JTCVS 02  485 patients
composite TE Risk 7% per pt yr
Mechanical Valves

- Thromboembolic event rate
  - 1-4%/pt-year

- Anticoagulant related hemorrhage rate
  - 2-5%/pt-year
Risk Factors for Thromboembolism

- Mechanical valve implant
- Atrial Fibrillation
- Increased LV cavity size/LV dysfunction
- Regional Wall Motion Abnormality
- Depressed Ejection Fraction
- Previous Thromboembolism
- Hypercoagulability
Anticoagulants - Coumarins

- Development/clinical use began in the 1920s
- Used for long-term anticoagulation therapy
  - Oral anticoagulant
  - Produces a functional deficiency of Vitamin K
    - several clotting factors on Vitamin K
  - Takes 36 hours to achieve a therapeutic blood level which will last 4 - 5 days
- Blood levels can vary
  - patients must be checked regularly
Minimally Invasive Aortic Valve
Aortic Valve
Freedom from Valve Dysfunction


Aortic Valve Complications

- Thromboembolism
- Anti-coagulant related hemorrhage
- Valve dysfunction/structural failure
- Para-valvular leak
- Re-operation
- Endocarditis
- Hemolysis
- Death

*Complications for both valves are defined as: TE, ACH(anti-coagulant related hemorrhage), valve dysfunction (Edwards Perimount®) or structural failure(St. Jude Medical® mechanical heart valve), PV leak, reoperation, endocarditis, hemolysis, or death.
Aortic Valve Survival

- Early (hospital) death - 3-6%
- Time-related survival
  - 5 years - 75%
  - 10 years - 60%
  - 15 years - 40%
- Mode of death
  - Early due to CHF, hemorrhage, infection, CVA
  - Sudden - 20%
  - Device related - 20%
Aortic Valve

Risk Factors for Survival after AVR
- Advanced age
- Functional status (NHYA class)
- Depressed LV function (aortic incompetence)
- Coronary artery disease
- Presence of endocarditis
- Aneurysm of ascending aorta
- Mismatch of prosthesis and body size