<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Rheumatic (Rim or Commissures)</td>
<td></td>
</tr>
<tr>
<td>Calcific Degenerative</td>
<td></td>
</tr>
<tr>
<td>Bicuspid</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from C. Otto, Principles of Echocardiography, 2007
Rare causes

• Congenital Aortic stenosis

• Severe artherosclerosis of aorta and aortic valve (In Hyperlipoproteinemia type II)

• Rheumatoid arthritis with aortic valve involvement
Bicuspid aortic valve

“Fish mouth opening”
In patients undergoing AVR for aortic stenosis.

**Distribution by age group of BAV versus TAV**

*Circulation* 2005;111: 920-925
Calcific Aortic Valve Disease

Aortic Stenosis

VS

Aortic Sclerosis

- Paget’s disease
- Age-related calcific
- Genetic polymorphism
- ESRD
- CV risks factor (DM, HT, LDL, smoking)
Aortic Stenosis

Aortic Sclerosis

- Defined as ...
  - calcification and thickening of the aortic valve *without* significant outflow obstruction (gradient < 20 to 25 mmHg)
Aortic disease

Calcific Aortic Valve Disease

Can Statins Slow progression of disease?

- SEAS study (N=1800)
  - Simvastatin + Ezetimibe
  - VS
  - Placebo

- ASTONOMER study (N=269)
  - Rosuvastatin
  - VS
  - Placebo

No Statistically Significant
(Mortality, time to AVR)
Rheumatic Aortic Stenosis

- Developing Country
- Frequently combined AS + AR
- Usually combined with Rheumatic Mitral Valve Involvement
Pathophysiology

AS

LV outflow obstruction

LV systolic P
LV mass
LV Ejection Time
O2 consumption
LV diastolic P
Blood supply $\rightarrow$ ischemia
Aortic P

LV failure & myocardial ischemia
Aortic pressure gradient & AVA correlation

Severe: Remember: 4-40 (Vmax 4 m/sec, AV mean PG 40 mmHg)
AVA 1.0 cm²

Moderate: (Vmax 3-4 m/sec, AV mean PG 20-40 mmHg)
AVA 1.0-1.5 cm²
Aortic pressure gradient & AVA correlation

AV mean PG 20 mmHg correlate with AVA 1.0 cm²
AV mean PG 40 mmHg correlate with AVA 0.8 cm²
Hemodynamic

\[
\text{SBP} \times \frac{\text{LV diameter}}{2 \times \text{LV wall thickness}} = \text{LV wall stress}
\]
Ejection fraction and wall stress relationship

Hemodynamic

LA pressure → Atrial fibrillation

LVEDP
Cardiac output in response to exercise

Systolic ejection time

Heart rate

Cardiac output in response to exercise

Rise in blood pressure < 10 mmHg (Severe obstruction)

Rise in blood pressure < 10 mmHg (Severe obstruction)
Hemodynamic

High LVEDP & Low Aortic Pressure

Subendocardium Myocardial Ischemia
Clinical manifestation

- Dyspnea on exertion
- Angina 5 yrs.
- Syncope 3 yrs.
- Heart failure 2 yrs.

Bicuspid AS onset 50-70 year-old
Tricuspid AS > 70 year-old

Natural History of Aortic Stenosis
Heydes syndrome

Aortic stenosis + LGIB
(Angiodysplasia: most common Rt. side colon)

Degenerative disease in elderly

Aortic stenosis
Hypertrophic cardiomyopathy

Acquired vWF syndrome type 2A
Gastrointestinal bleeding
Gastrointestinal angiodysplasia
Physical examination

• Pulsus parvus et tardus
  ➔ Severity

• SEM radiate to neck

• Gallavardin phenomenon
• Single S2 or paradoxical S2
Physical examination

- **S2**
  - Single S2 or
  - Paradoxical split S2

- **S4** due to LV stiffness

Heavy calcified and immobility

A2 delayed closure (esp. LBBB)
Dynamic Auscultation

Aortic Stenosis ➔ All Soft

↓ Valsava (Decrease Preload ➔ Decrease aortic blood flow)

↓ Hand grip (Increase afterload ➔ Decrease aortic blood flow)
ECG
CXR

Poststenotic dilatation

Roundening of apex
Prognosis

Asymptomatic Gradient → Prognosis

Hemodynamic progression
AVA -0.12 cm²/year
AV Vmax 0.32 m/sec/year
AV mean PG 7 mmHg/year

<3.0 m/s
3.0-4.0 m/s
>4.0 m/s
## Classification of Aortic stenosis severity based on ACC/AHA guideline

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Valve Anatomy</th>
<th>Valve Hemodynamics</th>
<th>Hemodynamic Consequences</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At risk of AS</td>
<td></td>
<td>Aortic $V_{\text{max}} &lt; 2 \text{ m/s}$</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
| B     | Progressive AS | Mild-to-moderate leaflet calcification of a bicuspid or trileaflet valve with some reduction in systolic motion or Rheumatic valve changes with commissural fusion | Mild AS: Aortic $V_{\text{max}} 2.0-2.9 \text{ m/s or mean } \Delta P < 20 \text{ mm Hg} $

Moderate AS: Aortic $V_{\text{max}} 3.0-3.9 \text{ m/s or mean } \Delta P 20-39 \text{ mm Hg}$ | Early LV diastolic dysfunction may be present | None |
| C: Asymptomatic severe AS |  |  |  |  |  |
| C1 Asymptomatic severe AS | Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening | Aortic $V_{\text{max}} \geq 4 \text{ m/s or mean } \Delta P \geq 40 \text{ mm Hg}$

AVA typically is \(< 1.0 \text{ cm}^2$ (or $\text{AVAi} \leq 0.6 \text{ cm}^2/\text{m}^2$)

Very severe AS is an aortic $V_{\text{max}} \geq 5 \text{ m/s or mean } \Delta P \geq 60 \text{ mm Hg}$ | LV diastolic dysfunction

Mild LV hypertrophy

Normal LVEF | None: Exercise testing is reasonable to confirm symptom status |
| C2 Asymptomatic severe AS with LV dysfunction | Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening | Aortic $V_{\text{max}} \geq 4 \text{ m/s or mean } \Delta P \geq 40 \text{ mm Hg}$

AVA typically \(< 1.0 \text{ cm}^2$ (or $\text{AVAi} \leq 0.6 \text{ cm}^2/\text{m}^2$) | LVEF \(< 50\%$ | None |
## Classification of Aortic stenosis severity based on ACC/AHA guideline

<table>
<thead>
<tr>
<th>D: Symptomatic severe AS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D1</strong> Symptomatic severe high-gradient AS</td>
<td>Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening</td>
</tr>
<tr>
<td></td>
<td>Aortic ( V_{\text{max}} \geq 4 \text{ m/s} ) or mean ( \Delta P \geq 40 \text{ mm Hg} )</td>
</tr>
<tr>
<td></td>
<td>Aortic valve area typically ( \leq 1.0 \text{ cm}^2 ) (or ( \text{AVA}_\text{I} \leq 0.6 \text{ cm}^2/\text{m}^2 )) but may be larger with mixed AS/AR</td>
</tr>
<tr>
<td></td>
<td>Aortic ( V_{\text{max}} \leq 1.0 \text{ cm}^2 ) with resting aortic ( V_{\text{max}} \leq 4 \text{ m/s} ) or mean ( \Delta P \leq 40 \text{ mm Hg} )</td>
</tr>
<tr>
<td></td>
<td>Dobutamine stress echocardiography shows ( \text{AVA} \leq 1.0 \text{ cm}^2 ) with ( V_{\text{max}} \geq 4 \text{ m/s} ) at any flow rate</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| D2 Symptomatic severe low-flow/low-gradient AS with reduced LVEF | Severe leaflet calcification with severely reduced leaflet motion |
|   | Aortic valve area typically \( \leq 1.0 \text{ cm}^2 \) with resting aortic \( V_{\text{max}} \leq 4 \text{ m/s} \) or mean \( \Delta P \leq 40 \text{ mm Hg} \) | LV diastolic dysfunction |
|   | Dobutamine stress echocardiography shows \( \text{AVA} \leq 1.0 \text{ cm}^2 \) with \( V_{\text{max}} \geq 4 \text{ m/s} \) at any flow rate | LV hypertrophy |
|   |   | LVEF \( \leq 50\% \) |

| D3 Symptomatic severe low-gradient AS with normal LVEF or paradoxical low-flow severe AS | Severe leaflet calcification with severely reduced leaflet motion |
|   | Aortic valve area typically \( \leq 1.0 \text{ cm}^2 \) with aortic \( V_{\text{max}} \leq 4 \text{ m/s} \) or mean \( \Delta P \leq 40 \text{ mm Hg} \) | Increased LV relative wall thickness |
|   | Indexed \( \text{AVA} \leq 0.6 \text{ cm}^2/\text{m}^2 \) and stroke volume index \( < 35 \text{ mL/m}^2 \) | Small LV chamber with low stroke volume |
|   | Measured when patient is normotensive (systolic BP \( < 140 \text{ mm Hg} \)) | Restrictive diastolic filling |
|   |   | LVEF \( \geq 50\% \) |

AR indicates aortic regurgitation; AS, aortic stenosis; AVA, aortic valve area; \( \text{AVA}_\text{I} \), aortic valve area indexed to body surface area; BP, blood pressure; HF, heart failure; LV, left ventricular; LVEF, left ventricular ejection fraction; \( \Delta P \), pressure gradient; and \( V_{\text{max}} \), maximum aortic velocity.
Progression from Aortic sclerosis → Severe aortic stenosis

Mean about 7 years

## From Unicuspid to Quadricuspid

<table>
<thead>
<tr>
<th>Unicuspid</th>
<th>Bicuspid</th>
<th>Tricuspid</th>
<th>Quadricuspid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate with AS</td>
<td>Associate with AR&gt;AS</td>
<td></td>
<td>Associate with AR</td>
</tr>
</tbody>
</table>
Unicuspid

Unicommissural

A lateral attachment of the valve orifice to the aorta

estimated incidence of 0.02%

eccentric “teardrop” opening may also be associated with dilation of the ascending aorta.
Bicuspid AV and Aortic root dilatation (Aortopathy + flow disturbance)
Patterns of bicuspid aortopathy

**TYPE 1**
Dilatation of tubular ascending aorta primarily along convexity of aorta, with mild to moderate root dilatation

**TYPE 2**
Arch dilatation with involvement of tubular ascending aorta, with relative sparing of root

**TYPE 3**
Isolated aortic root involvement with normal tubular ascending aorta and arch dimensions

- RCC-LCC fusion
- RCC-NCC fusion
- Younger age & genetic
Bicuspid AV and Coarctation of aorta

Bicuspid AV $\Rightarrow$ 10% Coarctation of aorta
Coarctation of aorta $\Rightarrow$ 50% Bicuspid AV
Quadricuspid subtype

Most common

A. Four equal-sized cusps
B. Three equal-sized cusps and one smaller cusp
C. Two equal larger cusps and two equal smaller cusps
D. One large cusp, two intermediate-sized cusps and one smaller cusp
E. Three equal-sized cusps and one larger cusp
F. Two equal larger cusps and two unequal smaller cusps
G. Four unequal cusps.

Medical management and Follow up

Mild AS  F/U echo q 3-5 years
Moderate AS F/U echo q 1-2 year(s)

• Rx Systemic hypertension
• Diuretics use with caution (may cause hypotension)
• ACEI should be used with caution in LV systolic dysfunction.
• Avoid Betablocker (worsening LV function)
Management in critical AS

– Vasodilator → Nitroprusside (decrease afterload)
– Inotropic agent
– Preload optimization

– Atrial arrhythmia → Abrupt decompensation
  • Cardioversion is recommended
### Summary of Recommendations for AS: Timing of Intervention

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR is recommended for symptomatic patients with severe high-gradient AS who have symptoms by history or on exercise testing (stage D1)</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>AVR is recommended for asymptomatic patients with severe AS (stage C2) and LVEF &lt;50%</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>AVR is indicated for patients with severe AS (stage C or D) when undergoing other cardiac surgery</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>AVR is reasonable for asymptomatic patients with very severe AS (stage C1, aortic velocity ≥5.0 m/s) and low surgical risk</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>AVR is reasonable in asymptomatic patients (stage C1) with severe AS and decreased exercise tolerance or an exercise fall in BP</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>AVR is reasonable in symptomatic patients with low-flow/low-gradient severe AS with reduced LVEF (stage D2) with a low-dose dobutamine stress study that shows an aortic velocity ≥4.0 m/s (or mean pressure gradient ≥40 mm Hg) with a valve area ≤1.0 cm² at any dobutamine dose</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>AVR is reasonable in symptomatic patients who have low-flow/low-gradient severe AS (stage D3) who are normotensive and have an LVEF ≥50% if clinical, hemodynamic, and anatomic data support valve obstruction as the most likely cause of symptoms</td>
<td>IIa</td>
<td>C</td>
</tr>
<tr>
<td>AVR is reasonable for patients with moderate AS (stage B) (aortic velocity 3.0–3.9 m/s) who are undergoing other cardiac surgery</td>
<td>IIa</td>
<td>C</td>
</tr>
<tr>
<td>AVR may be considered for asymptomatic patients with severe AS (stage C1) and rapid disease progression and low surgical risk</td>
<td>IIb</td>
<td>C</td>
</tr>
</tbody>
</table>

Nishimura et al. JACC Vol. 63, No. 22, 2014
2014 AHA/ACC Valvular Heart Disease Guideline
Lack of contractile reserve has been associated with lower operative survival rate (6% vs. 33%)

Circulation: Cardiovascular Imaging. 2014; 7: 545-551
The relationship between transvalvular flow and transvalvular gradient

![Graph showing the relationship between transvalvular flow and transvalvular gradient for different valve areas.](image)
Balloon valvulotomy

- Acute hemodynamic effect
  - 50% gradient reduction
  - AVA increase 0.2-0.3 cm²

- In hospital Mortality rate 10%

- No benefit long term outcome

TAVR
(Transcatheter aortic valve replacement)

SAPIEN

CoreValve
<table>
<thead>
<tr>
<th>Features</th>
<th>Edward Sapiens valve</th>
<th>Medtronic core valve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td>Porcine pericardium</td>
<td>Bovine Pericardium</td>
</tr>
<tr>
<td><strong>Delivery</strong></td>
<td>Balloon mounted</td>
<td>Self Expandable</td>
</tr>
<tr>
<td><strong>Vascular access</strong></td>
<td>22-24F sheath</td>
<td>18F sheath</td>
</tr>
<tr>
<td>(Femoral artery minimum</td>
<td>(XT valve 18 F access possible)</td>
<td></td>
</tr>
<tr>
<td>diameter 7mm required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LV Apical approach</strong></td>
<td>Possible</td>
<td>Not possible</td>
</tr>
<tr>
<td></td>
<td>(Rather not required)</td>
<td></td>
</tr>
<tr>
<td><strong>Implantation</strong></td>
<td>Requires induced</td>
<td>Can be delivered in</td>
</tr>
<tr>
<td></td>
<td>asystole (Rapid pacing)</td>
<td>Beating heart</td>
</tr>
<tr>
<td><strong>Staged deployment</strong></td>
<td>Not possible</td>
<td>Reposition Possible</td>
</tr>
<tr>
<td>(Partial Retrieval)</td>
<td></td>
<td>(Only minor adjustment)</td>
</tr>
<tr>
<td><strong>Main force fixing the valve</strong></td>
<td>Aortic elasticity</td>
<td>Radial force also</td>
</tr>
<tr>
<td></td>
<td>dependent</td>
<td>involved</td>
</tr>
<tr>
<td><strong>Ascending Aortic Support</strong></td>
<td>Nil</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Coronary Ostium/blood flow</strong></td>
<td>Unrelated</td>
<td>Can be related to</td>
</tr>
<tr>
<td><strong>Potential AV block</strong></td>
<td>Less</td>
<td>strut</td>
</tr>
<tr>
<td><strong>Long term outcome</strong></td>
<td>Comparable (PRAGMATIC study JACC Feb 2013)</td>
<td>High</td>
</tr>
</tbody>
</table>
PARTNER
(Placement of AoRtic TraNscathetER valves)

N Engl J Med 2010; 363:1597-1607
PARTNER
(Placement of AoRtic TraNscathetER valves)

Death from any cause or stroke

Death from any cause

Cohort A : High risk but operable

Cohort B : Inoperable

40% RRR

N Engl J Med 2010; 363:1597-1607

PARTNER
(Placement of AoRtic TraNscathetER valves)

• Atrial fibrillation, Bleeding
  – SAVR > TAVR

• Vascular complication, Stroke or TIA
  – TAVR > SAVR

**PARTNER 2**

Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients

Symptomatic Severe AS (N=2032), mean age 81 ± 6.7 yo.  
STS ≥ 4 and ≤ 10 (mean 5.8)  
Assessment by Heart Valve team

Intermediate risk for AVR

- Transfemoral access?  
  - Y: Transfemoral  
    - 1:1 Randomization  
      - TAVR (Sapien XT)  
      - Primary Outcome: All Cause Mortality + Major Stroke at 2 year (Non-inferiority)
  - N: Transapical  
    - 1:1 Randomization  
      - TAVR (Sapien XT)  
      - Primary Outcome: All Cause Mortality + Major Stroke at 2 year (Non-inferiority)

- Inoperable  
  - Transfemoral access?  
    - Y: 1:1 Randomization  
      - TAVR (Sapien XT)  
      - Primary Outcome: All Cause Mortality + Major Stroke at 1 year (Non-inferiority)
    - N: Not in study  
      - TAVR Sapien  
      - Primary Outcome: All Cause Mortality + Major Stroke at 1 year (Non-inferiority)
PARTNER 2

Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients

Hazard ratio, 0.89 (95% CI, 0.73–1.09)
P=0.25

Death from Any Cause or Disabling Stroke (%)

Months since Procedure

No. at Risk
TAVR 1011 918 901 870 842 825 811 801 774
Surgery 1021 838 812 783 770 747 735 717 695

PARTNER 2
(Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients)

• Atrial fibrillation, Major Bleeding
  – SAVR > TAVR

• Vascular complication, TIA
  – TAVR > SAVR

## Recommendations for AS: Surgical AVR or TAVR

**Table 10. Summary of Recommendations for AS: Choice of Surgical or Transcatheter Intervention**

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical AVR is recommended in patients who meet an indication for AVR (Section 3.2.3) with low or intermediate surgical risk</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>For patients in whom TAVR or high-risk surgical AVR is being considered, members of a Heart Valve Team should collaborate to provide optimal patient care</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>TAVR is recommended in patients who meet an indication for AVR for AS who have a prohibitive surgical risk and a predicted post-TAVR survival &gt;12 mo</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>TAVR is a reasonable alternative to surgical AVR in patients who meet an indication for AVR (Section 3.2.3) and who have high surgical risk (Section 2.5)</td>
<td>IIA</td>
<td>B</td>
</tr>
<tr>
<td>Percutaneous aortic balloon dilation may be considered as a bridge to surgical or transcatheter AVR in severely symptomatic patients with severe AS</td>
<td>IIb</td>
<td>C</td>
</tr>
<tr>
<td>TAVR is not recommended in patients in whom existing comorbidities would preclude the expected benefit from correction of AS</td>
<td>III: No Benefit</td>
<td>B</td>
</tr>
</tbody>
</table>

AS indicates aortic stenosis; AVR, aortic valve replacement; COR, Class of Recommendation; LOE, Level of Evidence; N/A, not applicable; and TAVR, transcatheter aortic
Surgical AVR

Prosthetic Valves

Biological
- Stentless Porcine Valves
  - Edwards Prima Plus
  - Medtronic Freestyle
  - SJM Quattro Valve
  - T-SPV
- Porcine Valve
  - CE SAV
  - Hancock MO
  - Hancock II
  - Medtronic Mosaic
  - Medtronic Standard
  - St. Jude Medical Bio

Mechanical
- Stented
  - Medtronic-Hall Prosthesis
  - Sorin Allcarbon
- Tilting Disc Valve
  - CE PERIMOUNT
- Bileaflet Valve
  - ATS open pivot (Standard Series)
  - Edwards Mira
  - On-X
  - Sorin Bicarbon
  - St. Jude Medical bileaflet
    - Masters
    - Masters with Silzone Coating
    - Regent
    - Standard
    - Sulzer CarboMedics

On-X
Estimates of freedom from structural valve deterioration (SVD) for patients undergoing porcine aortic valve

Summary of Recommendations for Prosthetic Valve Choice

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice of valve intervention and prosthetic valve type should be a shared decision process</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>A bioprosthesis is recommended in patients of any age for whom anticoagulant therapy is contraindicated, cannot be managed appropriately, or is not desired</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>A mechanical prosthesis is reasonable for AVR or MVR in patients &lt;60 y of age who do not have a contraindication to anticoagulation</td>
<td>IIa</td>
<td>A</td>
</tr>
<tr>
<td>A bioprosthesis is reasonable in patients &gt;70 y of age</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>Either a bioprosthetic or mechanical valve is reasonable in patients between 60 y and 70 y of age</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>Replacement of the aortic valve by a pulmonary autograft (the Ross procedure), when performed by an experienced surgeon, may be considered in young patients when VKA anticoagulation is contraindicated or undesirable</td>
<td>IIb</td>
<td>C</td>
</tr>
</tbody>
</table>
Ross Procedure

Pulmonary autograft root and valve in aortic position, with coronary arteries reattached.
Hemodynamic in Aortic stenosis
Gorlin formula

Flow across the valve

\[
\text{AVA} = \frac{\text{CO} \times 1000}{(\text{systolic time} \times \text{HR})} \times \sqrt{\text{AV mean PG}}
\]

\[
\text{MVA} = \frac{\text{CO} \times 1000}{(\text{diastolic time} \times \text{HR})} \times \sqrt{\text{MV mean PG}}
\]
Pressure gradient in AS

Peak to peak gradient = 70% of Peak instantaneous gradient
AS VS HOCM

Pulsus parvus
and tardus in AS

Late dynamic obstruction

Slow slope
Anacrotic notch

Spike Dome

HOCM
Pressure recovery phenomenon

Echocardiography may overestimate true gradient

Aortic root size < 3 cm

Pressure recovery (small aortic root size)
Pressure Volume Loop

![Pressure Volume Loop Diagram](image-url)
Hypertension and Aortic Stenosis

Trojan Horse (Blood flow)

Gate (Aortic stenosis)

Army (Hypertension)

Ejection flow → Resistance → Change in transvalvular flow → decrease aortic valve area

Systemic hypertension

Jens J. Kaden, Dariusch Haghi
Hypertension in aortic valve stenosis—a Trojan horse European Heart Journal Jun 2008,
References
Thankyou