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### Anesthetic Considerations for Patients with Aortic Stenosis

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# Anesthetic Consideration for Patients with Aortic Stenosis

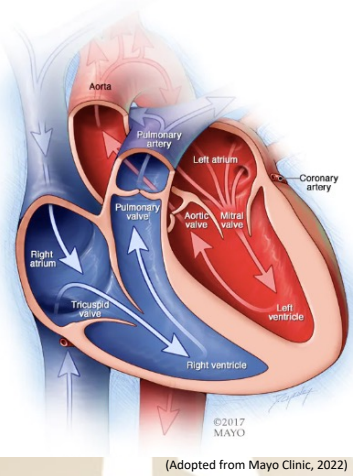
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## Introduction

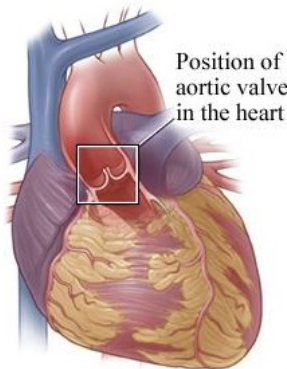
- The aortic valve lies between the left ventricle and the aorta.
- It is considered a semilunar valve that contains three leaflets.
- The normal aortic valve area is 2.5-3.5cm<sup>2</sup> (Nagelhout et al., 2022, p. 507).
- Upon ventricular systole, the aortic valve opens, allowing blood to enter the ascending aorta (Crawford & Bordon, 2021).
- Its function after closing prevents the backflow of oxygenated blood from the aorta to the left ventricle, which allows cardiac output to reach the body and coronary artery perfusion during diastole. (Crawford & Bordon, 2021).
- Aortic Stenosis is the narrowing of the aortic valve opening. (Crawford & Bordon, 2021).

## Importance

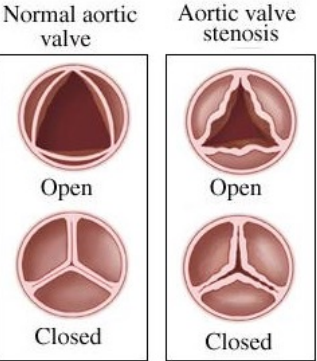
- Of the valvular heart diseases, aortic stenosis has become the most common (Hall & Hall, 2020, p.285).
- As many as 300,000 people in the United States are diagnosed with severe aortic stenosis every year (Frankel Cardiovascular Center, 2022).
- In the United States, the prevalence of aortic stenosis in those aged 65-74 is 1.4% and increases as high as 4.6% for those aged 75 and older (Whitener et al., 2020).
- In anesthesia, aortic stenosis produces a significant challenge and risk of adverse events for the patient undergoing anesthesia.



(Adopted from Mayo Clinic, 2022)



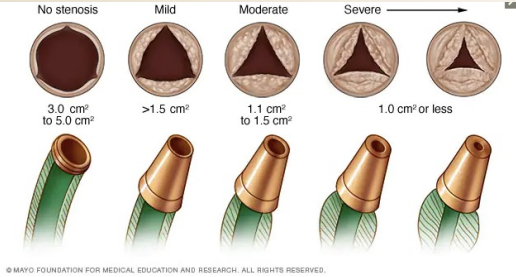
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(Adopted from Frankel Cardiovascular Center, 2022)

## Pathophysiological Process

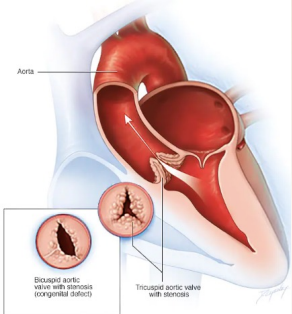
- The pathophysiology of aortic stenosis can stem from a variety of circumstances.
- These may include:
  - A congenital defect
    - A bicuspid aortic valve (more common in males) (Nagelhout et al., 2022, p. 507).
    - William's Syndrome (Schmidt et al., 2021)
  - Calcification of the aortic valve over time is the most common cause in older patients (Armstrong, 2022).
  - Rheumatic fever may cause scarring of the aortic valve leading to stiffened valve leaflets (Armstrong, 2022).
  - Radiation therapy can cause damage to the valve leading to stiffening (Mayo Clinic, 2022).
- Whichever the cause, the pathophysiology causes narrowing of the valve opening that reduces blood flow from the left ventricle to the aorta (Crawford & Bordon, 2021).
- This narrowing demands a greater systolic pressure by the left ventricle to ensure normal cardiac output (Nagelhout et al., 2022, p. 507).
- The increased systolic ejection pressure causes a pressure gradient between the left ventricle and the aorta. In severe cases, this gradient can be as high as 75 to 100 mmHg (Hall & Hall, 2020, p. 285).
- Due to the increased demand, the left ventricle hypertrophies to generate sufficient systolic ejection pressures and overcome the narrowed valve (Nagelhout et al., 2022, p. 507).



(Adopted from Mayo Clinic, 2022)

## Signs and Symptoms

- Symptoms of aortic stenosis typically do not occur until the stenosis becomes severe.
- The classic triad of symptoms of severe aortic stenosis include:
  - Angina (even in the absence of significant coronary artery disease)
  - Syncope
  - Congestive Heart Failure and consequent symptoms (Nagelhout et al., 2022, p. 507).
    - Shortness of breath on exertion or at rest
  - Decreased cardiac output from decreased stroke volume (Hall & Hall, 2020).
- Other symptoms include:
  - Arrhythmias including bradycardia and ventricular tachycardia (Armstrong, 2022).
  - Decreased appetite and failure to thrive (in children with aortic stenosis).
- On assessment, the carotid and peripheral pulses can be reduced in amplitude and slow rising (Armstrong, 2022).
- On auscultation, there is a crescendo-decrescendo systolic murmur heard at the right and left upper sternal border (Armstrong, 2022).



(Adopted from Mayo Clinic, 2022)

## Significance of Pathophysiology

- The severity of Aortic Stenosis is dependent on three factors:
  - Flow velocity
  - Mean gradient
  - Aortic valve area
- Mild aortic stenosis includes a valve area >1.5cm<sup>2</sup>, a mean gradient <20 mmHg, and a flow velocity <3 m/sec.
- Moderate aortic stenosis is considered when the valve area is 1-1.5cm<sup>2</sup>, the mean gradient is 20-40 mmHg, and the flow velocity is 3-4 m/sec.
- Severe aortic stenosis is considered when the valve area is <1cm<sup>2</sup>, the mean gradient is >40 mmHg, and the flow velocity is >4 m/sec.
- If the stenosis is bad enough, aortic regurgitation can occur upon closing of the valve allowing blood to backflow from the aorta into the left ventricle.
- The consequences of left ventricular concentric hypertrophy that arises from aortic stenosis include:
  - Decreased ventricular compliance
  - Increased myocardial oxygen demand
  - Ventricular remodeling (eventual dilation of the chamber) results in reduced ejection fraction and decreased cardiac output.
  - Increased filling pressures decrease the amount of coronary perfusion, making the patient more prone to ischemia (i.e., decreased myocardial oxygen supply) (Nagelhout et al., 2022, p. 507-508).

Table 1: Grading of aortic stenosis<sup>8/9</sup>

Echo parameter	Mild AS	Moderate AS	Severe AS
Peak jet velocity (m/s)	<3	3-4	>4
Mean gradient (mmHg)	<20	20-40	>40
AVA (cm <sup>2</sup> )	>1.5	1.5-1	<1
DI	>0.5	0.25-0.5	<0.25

AVA: Aortic valve area, AS: Aortic stenosis, DI: Dimensionless index

(Adopted from Nakanishi et al., 2021)

## Diagnosis and Treatment

- Aortic stenosis is confirmed by echocardiography (Armstrong, 2022).
- Treatment may include:
  - Open surgical aortic valve replacement is the preferred treatment if the patient can tolerate it (Frankel Cardiovascular Center, 2022).
  - Minimally invasive Transcatheter Aortic Valve Replacement (TAVR) is for those not candidates for open-heart surgery (Frankel Cardiovascular Center, 2022).

## Nursing Considerations

- The primary goal in patients with aortic stenosis is to avoid profound hypotension. (Nagelhout et al., 2022, p. 508).
- While managing anesthesia on patients with aortic stenosis, the nurse anesthetist must maintain hemodynamic stability by:
  - Keeping normal sinus rhythm with a heart rate of 70-80 bpm (to ensure adequate ventricular filling from the atrial kick).
  - Ensuring there is sufficient preload to maintain cardiac output.
  - Ensuring adequate coronary perfusion by maintaining diastolic blood pressure.
  - Avoiding myocardial depression
  - Maintaining a slight increase in afterload (Nagelhout et al., 2022, p. 508).

## Conclusion

- After reviewing the literature, it is determined that anesthesia can be performed with caution on patients with severe aortic stenosis.
- The study completed by Shetabi et al. (2022) concluded that a drug mixture of thiopental and midazolam was an effective agent for greater hemodynamic stability during induction.
- A study completed on a new benzodiazepine, remimazolam, showed its effectiveness in combination with remifentanyl as an induction agent with a timely dose of vasopressor in patients with severe aortic stenosis (Nakanishi, 2021).
- Schmidt et al. (2021) found that preoperative IV hydration, IV induction, and early use of vasoactive medication infusions led to fewer adverse events in patients with aortic stenosis.
- Regardless of the induction strategy utilized, the goal remains to maintain hemodynamic stability during induction to reduce the risk of adverse cardiac events.
- The more severe the stenosis, the more likely adverse events arise during anesthesia induction.

## References



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