

Risk

- Incidence in USA: 140,000 with ostium secundum ASD (70–80% of ASDs).
- Accounts for 7% of all congenital cardiac defects but roughly one-third (30–40%) of congenital cardiac defects in pts older than 40 y.
- Gender prevalence: Females >males, with a 2:1 ratio in isolated ASDs.
- Familial incidence: Significant if associated with P-R prolongation or forearm and hand abnormalities (Holt–Oram syndrome).
- Increased incidence in high altitude.

Perioperative Risks

- Periop mortality rate 1%
- Later in course, associated with atrial dysrhythmias, pulm Htn, and right heart failure
- Increased risk of atrial dysrhythmias, heart block (rare), and air embolus with surgical repair

Worry About

- Risk of infections endocarditis and paradoxical air embolization with IV access.

Overview

- Failure of closure of midseptal fossa ovalis.
- Usually asymptomatic early in life.
- 15% incidence of associated noncardiac anomalies.
- Associated with mitral valve prolapse (10–20%).
- L-to-R shunt increases pulm blood flow (shunt fraction proportional to ASD size).
- Late in course: Pulm Htn, right heart failure with possible shunt reversal, supraventricular arrhythmias.
- Uncorrected defect carries a mortality rate of 6% per y > age of 40.
- Diagnose by echocardiography and Doppler color flow echocardiography.
- >80% spontaneous closure in the first year of life for small defects.

Etiology

- Failure of septum secundum to fuse with septum primum secondary to defective formation or resorption of the septum primum, shortening of the septum secundum, or a combination of the three

Usual Treatment

- Digitalis and diuretics for child with CHF.
- Antiarrhythmics occasionally needed for atrial dysrhythmias.
- Surgery or transcatheter closure is indicated when Qp:Qs ratio $\geq 1.5:1$ in pts between 3–5 y.
- Surgery indicated if ASD >25 mm diameter or if anomalous pulm venous return is present.
- Endocarditis prophylaxis not indicated after successful simple surgical closure; indicated for 6 mo after repair using a prosthetic device.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Atrial dysrhythmias, right-sided heart failure, L-to-R shunting	Palpitations, SOB, DOE	Irate and rhythm, right heart enlargement, loud S ₁ , fixed S ₂ , and crescendo-decrescendo systolic murmur	TEE with color Doppler flow, four-chamber view, bicaval view, angiography, dye dilution study
RESP	Increased pulm blood flow Increased PVR	SOB, frequent URIs	Rales, wheezing	CXR
GI	Hepatic dysfunction if severe CHF	Jaundice	Hepatomegaly	LFTs, PT
RENAL	Renal dysfunction if severe CHF			Cr, BUN
CNS	Embolic stroke from chronic AFIB	Various changes		Head CT, cardiac ECHO if suspected emboli
MS			Holt-Oram syndrome Large left costal cartilage	

Key Reference: Findlow D, Doyle E: Congenital heart disease in adults, *Br J Anaesth* 78(4):416–430, 1997.

Perioperative Implications

Perioperative Preparation

- Narcotics and anticholinergics.
- Antibiotic prophylaxis.
- Continue digoxin if used for rate control.

Monitoring

- Routine monitors, arterial line, and CVP; TEE indicated for assessing anatomy before CPB and evaluating for air and residual shunting after CPB; central and peripheral temp monitoring

Induction

- IV induction is theoretically slowed by left to right shunt; inhalational induction is not significantly affected.

- Epidural with loss of resistance to saline technique to avoid air embolism.

Maintenance

- Avoid nitrous oxide to minimize size of air bubbles; inhalational, TIVA, or a combination of techniques are appropriate; watch for shunt reversal with hypothermia, hypercarbia, and hypoxemia.

Extubation

- In isolated lesions, pts can be extubated at the end of case if hemodynamically stable.

Adjuvants

- Watch for dysrhythmia from hypokalemia if pt is on digoxin and diuretics; maintain potassium of 4.0 or higher.

Postoperative Period

- Adequate analgesia for sternotomy or thoracotomy pain

Anticipated Problems/Concerns

- Paradoxical air emboli with vascular access
- Dysrhythmia (5–10% if no prerespair dysrhythmia)
- Heart failure
- Heart block after CPB (rare)
- Sternal infection (rare)
- Endocarditis

Atrioventricular and Bifascicular Heart Block

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Risk

- Prevalence: First degree (0.65–1.6%); second degree (0.003% in young adults; higher in organic heart disease); third degree (overall 0.02%; congenital 1:20,000 live births); increases with age presumably because of small vessel disease
- Inferior MI: Carries low mortality even if associated with high-degree AV block
- Anterior MI: If high-degree AV block results, then mortality approaches 80%

Perioperative Risks

- Progression of benign heart block to second degree type II or third degree
- Heart failure, myocardial and global ischemia, shock, and pacemaker failure

Worry About

- Autonomic changes influencing the degree of blockade
- Pacemaker failure or electrocautery interference
- Intracardiac wire or PA catheter placement leading to third-degree block

- β -blockers, calcium channel blockers, digoxin, and anticholinergics influencing the degree of heart block

Overview

- AV blocks: First degree (PR interval >0.20 sec). Block site =AV node. Usually benign. Associated with anterior MI, digitalis, and certain neuromuscular diseases.
- Second-degree type I (Mobitz I or Wenckebach): Increasingly prolonged PR interval until QRS has dropped. Block site =AV node (normal QRS). Usually benign. Usually does not progress over time to

second-degree type II or third degree. May progress acutely with anesthesia, autonomic influences, or intracardiac catheters/wires.

- Second-degree type II (Mobitz II): Fixed PR interval with occasional dropped QRS. Block site = usually infranodal (wide QRS) and permanent. The larger infranodal block site yields a slower ventricular rate and symptoms. It commonly progresses to third degree. High mortality is associated.
- Bifascicular block: Three “fascicles”/bundles” of nerves conduct via the ventricles: Right bundle branch, left anterior fascicle, and left posterior fascicle. When two of three are blocked, it is termed *bifascicular*. When third fascicle is blocked, pt is in third-degree heart block.
- Third degree: Atria and ventricles have separate pacemakers. Any atrial rhythm (e.g., AFIB/flutter) could be present. Ventricular rate/rhythm depends on the site of the blockade. The more infranodal block yields a slower ventricular rate. If only upper AV node is blocked, the patient may have junctional rhythm (normal QRS) and be more stable. If entire AV node is blocked, then the ventricular rate will be 20 to 40 bpm, and perfusion is compromised.

Etiology

- First degree: Usually benign or associated with anterior MI, digitalis
- Second-degree type I: Benign (athletes and children) from high vagal tone or from myocarditis,

mononucleosis, Lyme disease, amyloidosis, sarcoidosis, β -blockers, calcium channel blockers, digitalis, and volatile anesthetics

- Second-degree type II and bifascicular blocks: Anterior MI
- Third degree: Inferior MI (usually more stable HR >40); anterior MI with necrosis of bundle branches (unstable HR <40); severe hyperkalemia, hypermagnesemia; concurrent use of calcium channel and β -blockers; digitalis; high doses of volatile anesthetics, opiates, anticholinesterases; increased vagal input (laryngoscopy, esophagoscopy/TEE, peritoneal retraction, and ocular pressure); or congenital

Usual Treatment

- Dual chamber pacing is preferred pacing method in the AV block (level of evidence C)
- Class I indications for permanent pacing (all level of evidence C except as noted)
- 3rd, Type II 2nd degree AV block associated with the following:
 - Symptomatic or permanently drug-induced bradycardia
 - Ventricular arrhythmias
 - Exercise
 - Asymptomatic bradycardia with the following:
 - Asystole episodes >3 sec
 - Escape rhythms <40 bpm
 - Atrial flutter with bradycardic pauses >5 sec

- Wide QRS (level B)
- Isolated right-bundle block (level B)
- Cardiomegaly and/or LV dysfunction (3rd degree only, level B)
- Neuromuscular disease (level B)
- SA nodal catheter/operative ablation Bifascicular
- Intermittent 3rd degree (level B), Type 2 2nd degree (level B), and alternating bundle branch blocks Class IIa recommendations
- Asymptomatic 3rd degree with escape rhythm >40 bpm
- Asymptomatic 2nd degree at intra/intra-His levels (level B)
- First/second degree block with hemodynamic compromise (level B)
- Bifascicular w/ syncope or HV interval >100 ms, nonphysiologic infra-His block (level B) Class IIb recommendations
- Any AV block due to a drug that may have persistent effects (level B), or any AV block (level B) or bifascicular block (level C) due to neuromuscular disease Class III recommendations
- Asymptomatic 1st degree (level B) or Type 1 supra-His 2nd degree
- Any degree due to medications or transient conditions expected to resolve (level B)
- Any asymptomatic bifascicular block without some degree of concomitant AV block (level B)

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Heart failure	Syncope, SOB, DOE, “skipped beats,” last pacemaker battery replacement, fatigue	Bradycardia, JVD	ECG, ECHO, BNP
RESP	Pulm edema, hypoxia	Cough, pink sputum, orthopnea	Rales, tachypnea, wheezing, cough	CXR, pulse ox
RENAL	Prerenal failure, fluid retention	Oliguria, edema, fatigue, N/V	Edema, impaired mentation	BUN, Cr, FENA, lytes
NEURO	Poor cerebral perfusion	Lightheadedness, N/V	Impaired mentation	CT head

Key References: Stone ME, Salter B, Fischer A: Perioperative management of patients with cardiac implantable electronic devices, *Br J Anaesth* 107(S1):i16–i26, 2011; Epstein AE, DiMarco JP, Ellenbogen KA, et al: 2012 ACCF/AHA/HRS focused update incorporated into the ACCF/AHA/HRS 2008 guidelines for device-based therapy of cardiac rhythm abnormalities: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society, *J Am Coll Cardiol* 61(3):e6–e75, 2013; Gillis AM, Russo AM, Ellenbogen KA, et al: HRS/ACCF expert consensus statement on pacemaker device and mode selection, *J Am Coll Cardiol* 60(7):682–703, 2012.

Perioperative Implications

Preinduction/Induction/Maintenance

- Ascertain indication for and type of pacemaker, as well as functionality.
- Consider changing pacemaker to asynchronous mode if electrocautery is to be used.
- Have external and/or intravenous pacemaker and magnet available.
- Consider preinduction arterial catheter.
- Anticipate medication influences on autonomic nervous system balance (i.e., vagolysis from pancuronium, glycopyrrolate).
- Avoid intracardiac placement of central line wire.
- Consider using bipolar electrocautery; ensure proper electrocautery return pad placement away from the pacer.

Monitoring

- Low SaO₂ and high peak airway pressures can signify pulm edema.
- Low ETCO₂ may indicate low cardiac output.
- Arterial waveform: Diminished rate of rise may indicate poor cardiac output.
- Ensure adequate and constant ECG tracing with special attention to PR interval, QRS width, and AV association.

General Anesthesia

- Anticipate the effects of laryngoscopy, intubation, and TEE placement.
- Avoid rapid increases in volatile anesthetic concentration.
- Avoid high-dose opiates.
- Use β -blockers or calcium channel blockers carefully; use short-acting agents.
- Retraction or insufflation of vagal mediated structures can worsen bradycardia.
- Surgeon may need to stop the offending maneuver until pt is stabilized.
- Monitor and maintain normal serum electrolyte concentration.

Regional Anesthesia

- High thoracic spinal block will result in bradycardia even without preexisting heart block.
- Preexisting heart block may worsen after sympatholysis.
- Atropine ineffective if heart block is below the AV node; use direct-acting agents.
- Use epinephrine immediately.
- Verify or induce euvoolemia.

Postoperative Period

- Obtain ECG to verify preop baseline and cardiology consult.

- Pacemaker interrogation by electrophysiology and return to previous mode.
- Perform physical exam looking for signs of heart failure.

Anticipated Problems/Concerns

- If heart block is at the AV node then:
 - AV conduction is worsened by increased vagal input, peritoneal insufflation, esophageal manipulation (intubation, TEE, and esophagoscopy), β -blockers, calcium channel blockers, high-dose opiates, and anticholinesterases.
 - AV conduction is improved by vagolysis (antimuscarinics), exercise, and isoproterenol.
- If the heart block is infranodal, then autonomic influences are opposite of the above.
- Development of a slow ventricular response rate <40–50 bpm is concerning.
- Ensure transcutaneous and/or transvenous pacemaker availability and practitioner knowledge.
- Have direct-acting sympathomimetics available.