Ventricular Septal Defect

Ventricular septal defect is a condition of abnormal interventricular communication due to a septal defect, resulting in intracardiac shunting of blood.

ANESTHETIC CONSIDERATIONS:

- **Shunt size and direction**
- **Paradoxic emboli – bubble precautions**
- Atrial tachyarrhythmias
- Associated cardiac defects
- **Pulmonary HTN** due to ongoing volume overload of the RV and pulmonary circulation (Eisenmengers)
- RV failure in pregnancy and with diastolic dysfunction
- Associated congenital anomalies

ANESTHETIC GOALS:

- Maintain preoperative hemodynamics to avoid exacerbation or reversal of shunt
- In presence of L-R shunt:
  - Preload – high-normal to maintain adequate systemic CO in presence of intracardiac shunt
  - Rate/rhythm – NSR
  - PVR – high-normal
  - Contractility
  - SVR – low-normal
- In presence of R-L shunt:
  - Preload – normal
  - Rate – high-normal to improve RV function
  - Rhythm – NSR
  - PVR – low
  - Contractility – high-normal to improve RV function
  - SVR – normal

HISTORY

- Heart failure
  - Exertional dyspnea, fatigue
  - FTT, diaphoresis with feeding in infants
- Arrhythmias – palpitations, presyncope
- Pulmonary HTN

PHYSICAL

- General – poor weight gain, pallor, cyanosis suggests shunt reversal or infundibular pulmonic stenosis
- CVS
  - Cardiomegaly
  - Holosystolic murmur loudest at LLSB – murmur becomes shorter, softer, and lower pitched as RV pressure increases; small muscular VSDs high pitched, occur only in early systole as muscle contraction closes defect
- Resp – increased work of breathing, pulmonary edema
- GI – hepatomegaly

INVESTIGATIONS

- Labs – CBC, lytes, Cr, liver enzymes, coags, ABG as indicated
- EKG – LVH, RVH, prior MI
- CXR – cardiomegaly, prominent PA, increased pulmonary vascular markings
- Echo
  - VSD size and location, RVP and PAP, gradients
  - Doppler – shunting pattern, holosystolic flow + diastolic flow
  - Contractility, orifice size, and relative ventricular pressures affect intensity of turbulence
    - Less flow if poor LV function, pulmonary HT, larger defects
- Cardiac cath
  - Performed if uncertain anatomy or uncertain PVR
    - PVR >6 Wood U/m2 despite pulmonary vasodilators considered unoperable

TABLE 18-1 (LAKE)

Size	Shunt	Gradient	PVR	RVP	RVH	LVH	Murmur
Small	Small L-R	High	N	N	No	Yes	Holosystolic
Medium	Mod to Lg L-R	20 mmHg	Mild ↑	Mild ↑	Mild	Yes	Holosystolic
Large	Lg L-R Small R-L	None	↑	↑	Yes	Yes	Decrescendo
Large with ↑PVR	R-L	None	↑	↑	Yes	No	Minimal or absent

OPTIMIZATION

- **Medical**
  - Manage CHF
    - See CHF document

- Endocarditis prophylaxis
  - Not required in presence of isolated VSD with L-R shunt (unless associated valve defect)
  - Required if cyanotic CHD
  - Required for 6mo post-repair if prosthetic material used
- **Surgical repair**
  - Goal – prevent pulmonary vascular obstructive disease, treat intractable CHF
  - Indications – refractory heart failure, FTT, recurrent pulmonary infections, pulmonary HTN
  - Contraindications – PVR: SVR > 0.7
  - Techniques
    - Percutaneous – transcatheter closure
    - Open – via median sternotomy

ANESTHETIC OPTIONS
- Regional – caution, uncontrolled SVR exacerbates R-L shunt
- GA – careful induction to maintain PVR: SVR ratio

ANESTHETIC SETUP
- **Drugs**
  - Vasopressors, vasodilators (systemic and pulmonary) to manipulate SVR:PVR
  - Inotropes if evidence of RV failure
- **Monitors**
  - Consider need for artline, CVL, TEE

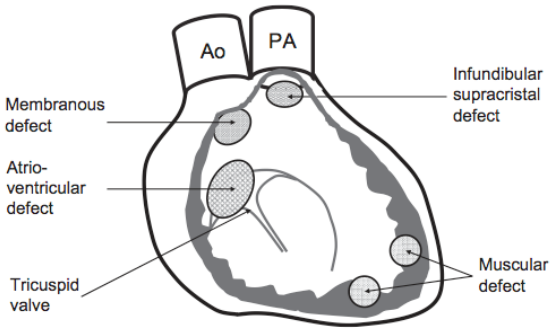
MANAGEMENT OF ANESTHESIA
- Similar principles as ASD (see ASD seminar)

DISPOSITION & MONITORING
- Monitor for low cardiac output syndrome

COMPLICATIONS
- Air embolism
- RVOT obstruction
- Irreversible pulmonary HT → RV failure
- Eisenmenger's syndrome with shunt reversal → hypoxemia

OBSTETRICS
- Higher incidence of fetal cardiac lesions
- Pregnancy has minimal impact on small non-restrictive VSD
  - L-R shunt may increase due to ↑CO in pregnancy, however this is counterbalanced by ↓SVR
- Large shunts and PAH in pregnancy – risk of arrhythmias, ventricular dysfunction, progression of PAH
- VSD patients who survive to adulthood usually have Eisenmenger syndrome
  - Pregnancy contraindicated

PATHOPHYSIOLOGY
- **Epidemiology**
  - Most common congenital heart defect in children
  - Accounts for 30% of pediatric CHD
- **Etiology**
  - Congenital
  - Acquired
    - MI – 1-2%, 1wk post-MI new holosystolic murmur, ↑risk with ventricular septal aneurysm, presents with sudden worsening CHF, rapid progression to cardiogenic shock
    - Trauma – blunt (contusion →necrosis →perforation), penetrating (laceration)
- **Classification**
  - Type I
    - Subarterial (aka supracristal, 5%) – in region of subpulmonic infundibulum beneath AV valves; associated AI from AV prolapse
  - Type II
    - Perimembranous (aka infracristal, 75%) – in membranous septum near TV leaflet; associated TV aneurysms, subaortic stenosis
  - Type III
    - Inlet (aka AV canal, 5%) – in posterior septum of atrioventricular canal; associated TV and MV defects
  - Muscular (15%) – within muscular or trabecular septum; may become smaller during late systole; multiple defects (> 3) = swiss cheese septum



- **Associated cardiac defects**
  - Bicuspid aortic valve, aortic coarctation, RVOT obstruction, complex CHD
- **Natural Hx**
  - Diagnosed ~2-6 wks of age by new murmur
    - Coincides with expected ↓in PVR and associated shunting across defect
  - Spontaneous closure
    - More common than with ASD
    - Common in Type IV defects, may occur in Type I and II, rarely in Type III
    - Common in defects < 5mm, rare if > 6.5mm
  - Size of nonrestrictive VSD may decrease over time and become restrictive
- **Characterization by size**
  - Small
    - PVR: SVR < 0.3 and Qp/Qs < 1.4
  - Moderate
    - PVR: SVR > 0.3 and Qp/Qs 1.4 – 2.2
    - LAE, LV dilation, ↑PA pressures
  - Large unrestrictive
    - PVR: SVR > 0.3 and Qp/Qs > 2.2
- **Characterization by pathophysiology**
  - Restrictive
    - LV pressure > RV pressure
    - L-R shunt; magnitude of shunt determined by pressure gradient across VSD
    - ↑er L-R gradient, however limited flow through shunt; ↑PA diameter, N RVSP, N PVR, LVH
    - Minimal additional cardiac or pulmonary workload
  - Nonrestrictive
    - RVSP = LVSP
    - Shunt direction *and* magnitude determined by PVR:SVR ratio
    - L-R shunt – ↑pulmonary blood flow, ↑pulmonary HT, pulmonary edema ,↑myocardial work, LVH, RVH, ↑risk pulmonary infections
    - R-L shunt – hypoxemia
- **Pathophysiologic consequences**
  - Shunting
    - L-R shunt
      - LV output must to maintain systemic blood flow at normal levels; eventual high output heart failure
  - CHF
    - When PVR ↓s in infancy → overcirculation → CHF
  - Pulmonary HTN

REFERENCES

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