Catheter closure of ventricular septal defects: technical problems and solutions

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Large perimembranous inlet VSD – no role for a device
Different Amplatzer VSD devices

Muscular VSDs
- Closed routinely by catheter techniques
- Devices 4-18 mm sizes, waist 7 mm, discs = waist + 8 mm
- Waist should be 1 – 3mm larger than VSD

Catheter closure of perimembranous VSDs
- Role controversial

Patient selection for device closure of VSDs
- Haemodynamically significant Qp/Qs >1.5
- LA or LV enlargement
- Cardiomegaly on CXR
- Failure to thrive because of VSD
- Previous episode of infective endocarditis
- Arterial valve rim >4 mm
- AV valve rim >4 mm
### Soft indications for closing VSDs
*Developed since catheter closure*

- Better psychosocial impact on patient
- Avoid the inherent problems related to stigma of having a heart defect
- Employability
- Health insurance
- Heavy vehicle license
- Sports participation (as a professional)

### Device closure of ventricular septal defect

**Advantages:**
- Avoids median sternotomy scar
- Avoids cardiopulmonary bypass
- Shorter hospital stay
- Shorter recovery period

**Limitations:**
- Learning curve of operator
- Technical difficulties
- Potential complications related to device or technique
Closing VSDs

- Location of the muscular VSD helps in choosing the approach to close the defect
- Echocardiography is essential during implantation and deployment of the device and to assess residual defects
- Apical and mid-muscular VSDs - relatively easy to close with devices
- Perimembranous VSDs more complex to close with greater potential for complications
Arteriovenous loop

- **Arterio-venous loop**
  - Femoral artery to femoral vein
  - Femoral artery to right internal jugular vein
  - Femoral artery to hepatic vein - rare

- **Veno-venous loop**
  - Femoral vein to internal jugular vein by using trans-septal technique - rare

- **Without AV loop:**
  - Closure from retrograde arterial/LV method - rare

Arteriovenous loop

- Access the VSD from the LV
  - Judkins right/modified cut-off pigtail/end-hole catheter
  - Terumo glide wire to cross the defect and advance the catheter into the RV
  - Remove Terumo wire and advance the Rope/noodle wire to the SVC or pulmonary artery
Arteriovenous loop

• If wire is in the PA
  – Balloon wedge catheter from venous side to the PA with balloon inflated (to avoid trapping tricuspid valve)
  – Advance exchange length wire to the PA, remove the wedge catheter and replace with snare catheter
  – Snare the noodle wire and pull out of the vein
  – Advance delivery sheath over wire to the left ventricle or aorta
  – Remove dilator and wire slowly
  – Allow sheath to back bleed before flushing with saline
• If the wire is in the SVC
  – Advance the snare catheter to the SVC and snare the wire - much simpler approach

Arteriovenous loop

• Advance appropriate size device through delivery sheath and deploy the left disc in the left ventricle (under echo and fluoroscopy guidance)
• Pull LV disc and sheath to bring the disc to the septum, deploy the waist and the RV disc
• LV angiogram before releasing the device
TOE guidance for apical VSD

Technique of implantation
Anterior muscular VSD
RIJV approach
Technique of implantation

Anterior muscular VSD

Femoral venous approach

These defects are best approached from femoral venous route

Perimembranous VSD:
Selection for catheter closure

- Weight > 7-8 kgs
- Left ventricular enlargement
- Distance from aortic valve of > 3-4 mm
- No aortic regurgitation
- No aortic valve prolapse
Device closure of ventricular septal defect
Perimembranous VSD

Device closure of ventricular septal defect
Perimembranous VSD
Device closure of ventricular septal defect

Problems:

- Unable to advance sheath into the LV
- Hypotension after sheath placement
- Sheath kinking
  - Less likely with braided sheaths eg Torquevue
- Device entangled in the mitral valve after left disc has been deployed
- Device pulls through the defect into RV

Technique of implantation

Haemodynamic instability in small infant

- May happen in babies less than 6 kg
- Watch for relative TV stenosis-the sheath keeps the TV in closed position – may happen in high muscular VSD
  - Haemodynamic compromise due to stiff sheath
  - Withdraw sheath if still hypotensive after a few minutes
  - Try again
Device closure of ventricular septal defect

Other important problems:
- Suboptimal position of device
- Residual shunt
- Embolisation
- Haemolysis
- Heart block

Device closure of ventricular septal defect

Unusual anatomy with aneurysm
Suboptimal device position
Device closure of ventricular septal defect

Perimembranous VSD
Device embolisation – new device with residual shunt & haemolysis

Sheath does not advance into LV

Check for:
- smooth course of wire and catheters
- wire/sheath are not caught on tricuspid valve
- wire/sheath is not caught in RV trabeculations
- If in doubt, break the a-v circuit and start again
Problems during implantation
Position of device & cobra formation

Device entangled in the mitral valve during deployment

- Advance the sheath into the LV and recapture the left disc
- Open both discs, advance the sheath/device assembly into LV and recapture the device
- Pull the sheath tip closer to the ventricular septum and deploy the left disc
Device embolisation

- If the device is stuck in the valve (MV or TV) apparatus and cannot be retrieved easily - surgery a good option
- If the device is in the pulmonary artery or arterial circulation - can be retrieved with a snare
  - Avoid injury to the femoral artery

Europe VSD Registry

Perimembranous VSD device closure
+ Complete Heart Block requiring pacemaker:

13 (5%) pts

4 (1.4%) Transient
- 2 devices remained implanted
- 2 surgical removal of device

9 (3.6%) Permanent
- 5 early (within 1 week)
- 4 late (4-18 months later)
VSD closure with devices

- 5 centres in China, 412 patients, age 3 – 65 years, mean 16 yrs
- VSDs 3 -15 mm
- Devices used 4 – 20 mm, symmetric occluders used in 312 pts, asymmetric occluders in 86 pts
- During and after device implant, 10 had LBBB and 16 RBBB. All recovered in < 1 week
- 97% immediate success
- 6 patients (4 children and 2 adults) had CHB, recovered within 3 weeks (temporary pacemaker and steroids)
- No complications during follow up of 0.5 to 2 yrs

Nit Occlud VSD coil (PFM)

- Novel attachment mechanism, 6 Fr delivery catheter
- Controlled released coil similar to the PDA NitOcclud
- Stiff distal loops covered with Dacron filaments
- Distal coil diameter: 10, 12, 14, 18 mm
- Prox coil diameter: 6, 8, 10 mm
Occlusion of VSD using the PFM Nitinol Coil

Device closure of ventricular septal defect

- Most VSDs can be closed with devices
- Apical and mid-muscular VSDs relatively low risk procedures
- Amplatzer muscular VSD device is excellent for closure of muscular VSD from size 4-18 mm
- For smaller and complex patients perventricular approach is useful
- Perimembranous VSDs can be closed with devices but there are risks – so probably best to be selective
- Large VSDs should be treated surgically