Patient selection: Percutaneous Atrial Septal Defect Closure

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I have nothing to disclose.
Evaluation of ASD

- Detection of ASD
- Characterization of ASD anatomy (shape, location, number of defects)
- Sizing of ASD (maximal and minimal diameter)
- Rim assessment
- Indication to close an ASD?
- ASD suitable for device closure?
Evaluation of ASD

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Types of ASD

- Secundum or fossa ovalis defect – defect of septum primum (~ 75%)
- Superior sinus venosus or SVC defect usually associated with RULPV anomaly
- Inferior sinus venosus or IVC defect
- De-roofing of coronary sinus
- Primum ASD or partial AVSD – endocardial cushion defect
Which Echo technique?

- TTE (2D/3D)
- ICE
- TEE 2D
- TEE 3D

ASD Evaluation
Which Echo technique?

- TTE (2D/3D)
- ICE
- TEE 2D
- TEE 3D

ASD Evaluation
Transthoracic Echo (TTE)

SAX view

4-chamber view
Limitations of TTE

• Good for anterior and posterior rims but poor for the inferior rim
• May not be able to see superior sinus venosus defects
• Cannot reliably distinguish between fossa ovalis defect (true secundum) and inferior sinus venosus defect extending into fossa ovalis
• Not possible to reliably assess inferior vena cava/RA junction
Which Echo technique?

- TTE (2D/3D)
- ICE
- TEE 2D
- TEE 3D
Conventional 2DTEE
Better definition of anatomy
How many holes?

2D TEE 32°

2D TEE 102°
Conventional 2DTEE

- Better definition of anatomy
- Assessment of anatomy of superior sinus venosus ASD possible
- Still limited at IVC defect (oesophagus curving away from heart)
- Multi-fenestrations: true number of defects difficult to assess
Which Echo technique?

- TTE (2D/3D)
- ICE
- ASD Evaluation
- TEE 2D
- TEE 3D
Which echo technique?

**TEE**
- Good imaging quality
- Cheap
- Not convenient for the patient
- Usually done under sedation (rarely general anesthesia necessary)
- Requires an additional echocardiographer
- On LA side of device

**ICE**
- Good imaging quality
- Expensive
- More convenient for the patient
- Only local anesthesia needed
- No additional staff
- On RA side of device
Intracardiac echo (ICE)

Advantages: posterior septum
Which Echo technique?

TTE (2D/3D)  
ICE  
TEE 2D  
TEE 3D  
ASD Evaluation
3D TEE both atrial sides

LA view  RA view
3D TEE- RA aspect

More anatomical details in one view

Live 3D TEE zoom - RA aspect
What are the problems with 3D TEE?

- Learning curve
  - Technique
  - Images
- Familiarity needs to be gained in “easy cases” if to be of assistance in difficult anatomies
Limitations of TEE

- Semi-invasive → potential hazards
- Unpleasant for the patient → needs sedation/GE
- Still has limitations imaging IVC insertion, high superior defects, abnormal draining pulmonary veins...
- 3D TEE may overcome some of the limitations
Is echo always sufficient in detecting ASD?

ASD Evaluation

- TTE (2D/3D)
- ICE
- TEE 2D
- TEE 3D

+?
In patients with non-secundum defects MRI may provide additional information

Inferior sinus venosus defect

Courtesy to O. Ormerod
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Various shapes of ASD’s

Circular

oval

Slit like

multi-fenestrated
Multiple defects → in ~ 15% of ASD patients

P. Ewert
Multiple defects
2D TEE imaging in multiple planes

anteror and posterior cranial
Multiple defects
2D TEE imaging in multiple planes

3D aspect of the same patient
Evaluation of ASD

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Sizing of ASDs

Use always more than one sectional plane (X-plane)
Size of defect- ASD

3D TEE IAS- RA view

Multiple fenestrations

2 occluders in anterior position (cranial and caudal) → 2 additional posterior defects
Evaluation of ASD

• Detection of ASD
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• Sizing of ASD (maximal and minimal diameter)
• Rim assessment
• ASD suitable for device closure?
Rim assessment in 2DTEE

0 °

SAX 45 °

LAX 90 °
Rim assessment in 3D TEE

Rims named after the adjacent structures
Evaluation of ASD

- Detection of ASD
- Characterization of ASD anatomy (shape, location, number of defects)
- Sizing of ASD (maximal and minimal diameter)
- Rim assessment
- Indication to close an ASD?
- ASD suitable for device closure?
Do we have an indication to close an ASD?

- Symptoms
- or RV / RA enlarged* IB
- or QP:QS > 1.5
- or paradoxical embolism IIa C
- PAP < 2/3 of systemic pressure
- PVR ≥5WE but <2/3 SVR

*PVR < 5W
Do we have an indication to close an ASD?

RV dimensions

<table>
<thead>
<tr>
<th>Table 7 Reference limits and partition values of right ventricular and pulmonary artery size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference range</td>
</tr>
<tr>
<td>-----------------</td>
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<tr>
<td>RV dimensions (Figure 12)</td>
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<tr>
<td>Basal RV diameter (RVD 1), cm</td>
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<tr>
<td>Mid-RV diameter (RVD 2), cm</td>
</tr>
<tr>
<td>Base-to-apex length (RVD 3), cm</td>
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</tbody>
</table>

TTE 4- Chamber view

TEE 4- chamber view

ASE: Recommendations for Chamber quantification
Do we have an indication to close an ASD?

RA dimensions

<table>
<thead>
<tr>
<th>Table 9 Reference limits and partition values for left atrial dimensions/volumes</th>
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</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td><strong>Atrial dimensions</strong></td>
</tr>
<tr>
<td>LA diameter, cm</td>
</tr>
<tr>
<td>Reference range: 2.7–3.8, Mildly abnormal: 3.9–4.2, Moderately abnormal: 4.3–4.6, Severely abnormal: ≥4.7</td>
</tr>
<tr>
<td>LA diameter/BSA, cm/m²</td>
</tr>
<tr>
<td>Reference range: 1.5–2.3, Mildly abnormal: 2.4–2.6, Moderately abnormal: 2.7–2.9, Severely abnormal: ≥3.0</td>
</tr>
<tr>
<td>RA minor-axis dimension, cm</td>
</tr>
<tr>
<td>Reference range: 2.9–4.5, Mildly abnormal: 4.6–4.9, Moderately abnormal: 5.0–5.4, Severely abnormal: ≥5.5</td>
</tr>
<tr>
<td>RA minor-axis dimension/BSA, cm/m²</td>
</tr>
<tr>
<td>Reference range: 1.7–2.5, Mildly abnormal: 2.6–2.8, Moderately abnormal: 2.9–3.1, Severely abnormal: ≥3.2</td>
</tr>
<tr>
<td><strong>Atrial area</strong></td>
</tr>
<tr>
<td>LA area, cm²</td>
</tr>
<tr>
<td>Reference range: ≤20, Mildly abnormal: 20–30, Moderately abnormal: 30–40, Severely abnormal: &gt;40</td>
</tr>
<tr>
<td><strong>Atrial volumes</strong></td>
</tr>
<tr>
<td>LA volume, mL</td>
</tr>
<tr>
<td>LA volume/BSA, mL/m²</td>
</tr>
<tr>
<td>Reference range: 22 ± 6, Mildly abnormal: 29–33, Moderately abnormal: 34–39, Severely abnormal: ≥40</td>
</tr>
</tbody>
</table>

**ASE:** Recommendations for chamber quantification

*BSA,* Body surface area; *LA,* left atrial; *RA,* right atrial.

Bold italic values: Recommended and best validated.
Do we have an indication to close an ASD?

Qp/Qs can be estimated by using 2D echo and spectral Doppler measurements

\[
\begin{align*}
Qp &= RVOT\,VTI \times \pi \times \left( \frac{RVOT}{2} \right)^2 \\
Qs &= LVOT\,VTI \times \pi \times \left( \frac{LVOT}{2} \right)^2 \\
\text{Qp/Qs Ratio} &= \frac{Qp}{Qs}
\end{align*}
\]
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ASD suitable for device closure?

- Almost all secundum defects are suitable
- Maximum diameter 40mm for ASD
- Should have a rim on 3 sides
  - Multiple defects
    - Not a problem
  - Septum aneurysm
    - Not a problem
- Age
  - Not a problem
ASD- no aortic rim
Multiple septal defects

2D TEE, LAX-cranial (24mm) and caudal (16mm) defect
Multiple septal defects

Occluder attached to the delivery cable, caudal occluder „sandwiched“
ASD not suitable for device closure

2D TEE 105 und 195°
Measurement: 45 mm

3D TEE LA view
ASD not suitable for device closure

2D TEE 118°

3D TEE: LA aspect
Conclusions
How to select a patient for ASD closure?

- In evaluation of ASD we need to
  - ... detect the defects
  - ... characterize the ASD anatomy
  - ... size the ASD
  - ... assess the rims
  - ... identify patients with an indication to close an ASD
  - ... identify defects which are suitable for device closure

- Echo is usually sufficient to answer the questions

- Consider an additional MRI in patients with non-secundum defects and heart catheterization (PVR) when PAP > 50% of systemic pressure
Thank you for your attention!