ASD DEVICE CLOSURE: CURRENT STATUS

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I ANATOMICAL SUITABILITY (SECUNDUM ASD)

- **First-Line Indication:** Transcatheter device closure is the first-line treatment (Class I) for **Ostium Secundum ASDs**, which comprise 75 to 80 percent of all ASD cases, when anatomical and size criteria are met (stretched diameter typically 38 mm or less).
- **Excluded Morphologies and Modern Exceptions: Ostium Primum ASD** (15 percent) and **Unroofed Coronary Sinus ASD** (less than 1 percent) require surgical repair and cannot be closed percutaneously due to absent inferior rims and proximity to the AV valves and conduction system. While **Superior Sinus Venosus ASD** (5 to 10 percent) is traditionally repaired surgically, **transcatheter covered stent correction** in the SVC-RA junction is now an established interventional alternative in selected adults with suitable anatomy (after balloon test occlusion excludes pulmonary venous obstruction or sinus node dysfunction).
- **The Rim Requirement:** Adequate tissue rims of **5 mm or more** (superior/SVC, inferior/IVC, atrioventricular/mitral valve, right upper pulmonary vein, and posterior/coronary sinus rims) are required to anchor the device securely.
- **Aortic Rim Exception:** The **aortic (anterosuperior) rim** is most commonly deficient (less than 5 mm in up to 40 to 50 percent of secundum ASDs), but its isolated deficiency is not an absolute contraindication if other rims are robust and extreme device oversizing is avoided.
- **Inferior (IVC) Rim Deficiency:** A deficient **IVC (inferoposterior) rim** (less than 5 mm) carries the highest risk of device embolization and residual shunting and is generally a contraindication to percutaneous closure.

II INDICATIONS FOR CLOSURE (ESC 2020 / ACC/AHA 2018)

- **Hemodynamic Significance (Class I):** Evidence of **Right Ventricular (RV) volume overload** (RA/RV enlargement) without pulmonary arterial hypertension (PVR less than 3 Wood Units), regardless of symptoms.
- **Shunt Magnitude:** Typically corresponds to a pulmonary-to-systemic flow ratio (**Qp:Qs**) of **1.5:1 or higher**.
- **Paradoxical Embolism (Class IIa):** History of cryptogenic stroke, transient ischemic attack, or systemic paradoxical embolism (or platypnea-orthodeoxia syndrome) in the presence of an ASD, regardless of shunt size, once other causes and pulmonary vascular disease are excluded.
- **Pulmonary Hypertension Thresholds:**
  - **PVR less than 3 Wood Units (WU):** Standard transcatheter closure is recommended (Class I).
  - **PVR 3 to less than 5 WU:** Closure should be considered (Class IIa) if the shunt remains predominantly left-to-right (Qp:Qs greater than 1.5).
  - **PVR 5 WU or greater (Treat-and-Repair, Class IIb):** Fenestrated ASD closure may be considered only if targeted PAH medical therapy reduces PVR to **less than 5 WU** and a net left-to-right shunt (Qp:Qs greater than 1.5) is maintained.
  - **Contraindication (Class III): Eisenmenger syndrome** or severe PAH with persistent **PVR of 5 Wood Units or greater** despite medical therapy, right-to-left shunting, or exercise-induced desaturation.

Hemodynamic Profile on RHC	Shunt Direction (Qp:Qs)	2020 ESC ACHD Guideline Recommendation
PVR less than 3 Wood Units	Left-to-Right (Qp:Qs 1.5 or greater) with RV volume overload	**Class I:** Standard percutaneous device closure
PVR 3 to less than 5 Wood Units	Left-to-Right (Qp:Qs greater than 1.5)	**Class IIa:** Closure should be considered
PVR 5 WU or greater (Reversible)	PVR drops below 5 WU on PAH therapy with Qp:Qs greater than 1.5	**Class IIb:** Fenestrated closure (“Treat-and-Repair”)
PVR 5 WU or greater (Fixed / Eisenmenger)	Persistent PVR 5 WU or greater, or Right-to-Left shunt	**Class III (Harm):** Closure is strictly contraindicated

III PROCEDURAL TECHNIQUES

- **Defect Sizing:** Defect diameter and all six rims are assessed via **Transesophageal Echocardiography (TEE; 2D/3D)** or **Intracardiac Echocardiography (ICE)**. When balloon sizing is performed, the **stop-flow balloon sizing technique** (inflating a compliant sizing balloon only until color Doppler shunt flow ceases, rather than pulling a stretched waist across the septum) is the reference standard to prevent defect overstretching and device oversizing.
- **Imaging Paradigm Shift: Intracardiac Echocardiography (ICE)** is the procedural standard in high-volume adult centers, allowing high-definition visualization of the posteroinferior/IVC rim without general anesthesia or esophageal intubation.
- **Device Selection:** Self-centering nitinol double-disc devices—such as the **Amplatzer Septal Occluder (ASO)**, **Occlutech Figulla Flex II**, and **Cocoon/Cera** occluders—are preferred for moderate-to-large defects (up to 38 to 40 mm) and defects with deficient aortic rims. The **GORE Cardioform ASD Occluder** (ePTFE over a wire frame) offers a softer, conformable profile with very low erosion risk for small-to-moderate defects (up to 35 mm).
- **Left Atrial Pressure Testing in Older Adults:** In patients over 40 to 60 years of age or those with suspected LV diastolic dysfunction (HFpEF), **temporary balloon test occlusion for 10 to 15 minutes** with left atrial or pulmonary capillary wedge pressure monitoring is essential; if mean LA pressure rises above 20 mmHg (or increases by more than 10 mmHg), pre-treatment with heart failure therapy or a **fenestrated device** is required to prevent acute post-closure pulmonary edema.

IV COMPLICATIONS AND LIMITATIONS

- **Cardiac Erosion (0.1 to 0.3 percent):** A rare but catastrophic complication in which the device edge abrades the atrial roof or **aortic root**, leading to hemopericardium and **cardiac tamponade**. Risk is highest with **oversized devices** and combined deficient aortic and superior rims; requires urgent surgical device explantation and repair.
- **Device Embolization (0.5 to 1.0 percent):** Most commonly caused by an unrecognized deficient **IVC rim** or device undersizing; managed by percutaneous snare retrieval or surgical removal.
- **Atrial Arrhythmias and Conduction Disturbances:** New-onset **Atrial Fibrillation** or atrial flutter occurs in 1 to 6 percent of cases (particularly in older patients), while transient or complete AV block (less than 1 percent) can occur with large devices impinging on the triangle of Koch.
- **Device Thrombosis and Antiplatelet Therapy:** Patients require **6 months of antiplatelet therapy** (Aspirin 75 to 100 mg daily alone or Dual Antiplatelet Therapy with Aspirin plus Clopidogrel for 1 to 6 months per institutional/device protocol) and infective endocarditis prophylaxis until complete device endothelialization occurs.
- **Nickel Allergy:** Documented severe nickel hypersensitivity is a relative contraindication to bare nitinol devices (55 percent nickel); ePTFE-covered devices (**GORE Cardioform**) or surface-coated nitinol occluders (**Cocoon** platinum-coated or **Cera** titanium-nitride coated) may be considered.

V CURRENT EVIDENCE GIST

- **Device vs. Surgery:** Meta-analyses and registry data demonstrate that transcatheter device closure achieves equivalent closure success (greater than 96 to 98 percent) compared to surgery, while offering significantly lower complication rates and shorter hospital stays.
- **Elderly Patients (Over 60 Years):** Clinical studies confirm that patients over 60 years of age derive significant right ventricular reverse remodeling and functional improvement from ASD closure, provided masked **LV diastolic dysfunction (HFpEF)** is excluded via balloon occlusion testing and pre-existing atrial arrhythmias are managed.
- **Treat-and-Repair Strategy:** In patients presenting with baseline PVR of 5 Wood Units or greater, upfront targeted PAH pharmacotherapy (ERA plus PDE-5 inhibitor) to lower PVR below 5 Wood Units while maintaining Qp:Qs greater than 1.5, followed by **fenestrated ASD device closure**, is supported by the 2020 ESC ACHD Guidelines (Class IIb).

KEY REFERENCES

- **Baumgartner H, De Backer J, Babu-Narayan SV, et al.:** 2020 ESC Guidelines for the management of adult congenital heart disease, *European Heart Journal*, 2020.
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- **Rosenthal E, Qureshi SA, Jones M, et al.:** Correction of sinus venosus atrial septal defects with the 10 zig covered Cheatham-platinum stent: an international registry, *Catheterization and Cardiovascular Interventions*, 2021.