ALCOHOL SEPTAL ABLATION; CURRENT STATUS

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I CLINICAL INDICATIONS AND POSITION IN THE 2024 AHA/ACC & 2023 ESC ALGORITHM

- **Core Concept: Alcohol Septal Ablation (ASA)** (first performed by **Ulrich Sigwart in 1994/1995**) is a percutaneous catheter-based **Septal Reduction Therapy (SRT)** for **Hypertrophic Obstructive Cardiomyopathy (HOCM)** that infuses desiccated absolute (96 to 98 percent) ethanol into a target **first or second septal perforator branch of the LAD** to induce a localized, controlled **basal interventricular septal infarction**, resulting in basal septal akinesia/thinning, widening of the Left Ventricular Outflow Tract (LVOT), abolition of Systolic Anterior Motion (SAM) of the mitral valve, and reduction of SAM-mediated mitral regurgitation.
- **Strict Hemodynamic and Clinical Prerequisites for Any Septal Reduction Therapy (Class I):**
  - **Severe Drug-Refractory Symptoms:** NYHA Functional Class III or IV exertional dyspnea, limiting angina, or recurrent exertional syncope/presyncope despite maximally tolerated medical therapy.
  - **Hemodynamic Gradient Threshold:** Dynamic **LVOT peak instantaneous gradient of 50 mmHg or greater** at rest or with physiological provocation (Valsalva, standing, or upright exercise echocardiography) associated with **SAM-mediated obstruction**.
  - **Anatomical Septal Thickness:** Basal anterior septal thickness sufficient to safely perform the procedure (typically **15 to 16 mm or greater**).
  - **Strict Contraindication (Class III — Harm):** Septal reduction therapy (ASA or surgical myectomy) **must NOT be performed in asymptomatic patients** or in patients whose symptoms are well controlled on medical therapy, regardless of the magnitude of the resting or provoked LVOT gradient.
  - **The "Cardiac Myosin Inhibitor First" Shift (2024 AHA/ACC & 2023 ESC Guidelines):**
  - **Step 1 (First-Line Medical Therapy — Class I):** Non-vasodilating **Beta-Blockers** (titrated to resting HR <60 to 65 bpm) or **Non-Dihydropyridine Calcium Channel Blockers (Verapamil or Diltiazem)**.
  - **Step 2 (Refractory Symptoms — Class I Equal Options in 2024 AHA/ACC):** For patients remaining symptomatic on Step 1 therapy, the **2024 AHA/ACC HCM Guidelines** elevate **Cardiac Myosin Inhibitors (Mavacamten; Aficamten has since been studied in SEQUOIA-HCM)**, **Disopyramide**, and **Septal Reduction Therapy (Surgical Myectomy or ASA at an experienced center)** as **Class I options** based on shared decision-making.
  - **Landmark VALOR-HCM Trial (*JACC* 2022 / *Circulation* 2023):** Randomized HOCM patients already referred and guideline-eligible for SRT (Myectomy or ASA) to **Mavacamten vs. Placebo**; at 16 and 56 weeks, **more than 80 to 89 percent of patients treated with Mavacamten no longer met guideline criteria for SRT and chose not to undergo invasive ASA or surgery**—repositioning ASA in clinical practice to patients who fail, are intolerant of, or cannot afford/access myosin inhibitors, or who prefer a one-time procedural intervention over lifelong REMS echocardiographic monitoring.
  - **Guideline Class of Recommendation for ASA (Class I, Level B-NR):** In eligible adult HOCM patients in whom **Surgical Septal Myectomy is contraindicated or carries high risk due to advanced age, frailty, or serious comorbidities** (or who prefer a percutaneous approach after shared decision-making), **ASA is Class I recommended when performed at a Comprehensive HCM Center**.

II STEPWISE PROCEDURAL TECHNIQUE AND MANDATORY CONTRAST ECHO GUIDANCE

- **Pre-Procedural Cardiac CT Angiography Planning:** High-resolution Coronary CTA maps the origin, caliber, angulation, and myocardial perfusion territory of the **first and second septal perforator arteries** (which arise from the proximal LAD in >90% of cases, or occasionally from a diagonal, ramus, or RCA/PDA) and measures basal septal thickness.
- **Temporary Pacemaker Placement and Baseline Hemodynamics:** A **temporary transvenous pacemaker lead** is placed in the right ventricular apex (ideally an **active-fixation screw-in lead** via the internal jugular vein if baseline **LBBB** is present, given the >50% risk of complete heart block), and simultaneous **LV apex (via a transaortic pigtail without side-holes) and ascending aortic pressures** are recorded at rest, after a premature ventricular contraction (**Brockenbrough-Braunwald-Morrow sign**), and during Valsalva.
- **Over-the-Wire (OTW) Balloon Occlusion of the Target Septal Perforator:** A short compliant **Over-the-Wire (OTW) angioplasty balloon (1.5 to 2.5 mm)** is inflated at low pressure (4 to 6 atm) in the proximal target septal perforator. Complete balloon occlusion is mandatory to **prevent catastrophic retrograde reflux of absolute alcohol back into the main LAD** (which causes massive anterior STEMI).
- **Mandatory Myocardial Contrast Echocardiography (MCE — The Safety Cornerstone):**
  - **Technique:** Before any alcohol is drawn up, **1 to 2 mL of ultrasound contrast agent** (or agitated radiographic contrast/gelatin) is injected strictly through the central lumen of the inflated OTW balloon during continuous **Transthoracic Echocardiography (TTE)** in the apical 4-, 3-, and parasternal views.
  - **Confirmation Criteria:** MCE **must confirm that contrast opacification is restricted exclusively to the basal interventricular septum directly encompassing the exact point of mitral leaflet-septal (SAM) contact**.
  - **Absolute Abort Criteria:** If MCE shows contrast enhancing the **Left Ventricular free wall, apex, papillary muscles, or the Right Ventricular free wall / moderator band**, **alcohol must NOT be injected** into that branch (the balloon is deflated and a different septal sub-branch is wired), preventing non-target infarction, papillary muscle rupture/severe MR, or large VSD.
  - **Low-Dose Desiccated Ethanol Infusion:** Once MCE confirms the exact basal SAM contact zone (and balloon occlusion alone often produces an immediate stunned drop in the LVOT gradient), **desiccated 96–98% ethanol** is infused slowly (**0.08 to 0.1 mL per millimeter of basal septal thickness; typically 1.0 to 2.0 mL total**, significantly lower than historical 3 to 5 mL doses, which reduces complete heart block rates without sacrificing efficacy) over 3 to 5 minutes. The balloon is kept inflated for **10 minutes** after flushing with saline so all ethanol fixes in the tissue before balloon deflation.
  - **Bimodal ("Triphasic") Gradient Response:** The LVOT gradient drops **immediately** in the cath lab (due to acute myocardial stunning/akinesia), frequently **rebounds transiently at Days 2 to 5** (due to acute localized myocardial **edema** swelling the infarcted basal septum), and then **progressively declines over 3 to 12 months** as collagen scar contraction thins and remodels the basal septum.

III ALCOHOL SEPTAL ABLATION VS. SURGICAL EXTENDED MYECTOMY (MORROW PROCEDURE)

Clinical / Anatomical Parameter	Alcohol Septal Ablation (ASA)	Extended Surgical Septal Myectomy (Morrow)
Procedural Approach & Recovery	Percutaneous femoral/radial catheter; hospital stay **2–4 days**	Median sternotomy + cardiopulmonary bypass; hospital stay **5–7 days**

Clinical / Anatomical Parameter	Alcohol Septal Ablation (ASA)	Extended Surgical Septal Myectomy (Morrow)
Mechanism of LVOT Relief	**Coronary anatomy-dependent** coagulative necrosis -> scar thinning over **3–12 months**	**Direct visual muscular resection** -> **immediate** abolition of gradient
Typical Conduction Defect Induced	**Right Bundle Branch Block (RBBB) in 50–60%** (high CHB risk if baseline **LBBB** exists)	**Left Bundle Branch Block (LBBB) in 40–50%** (high CHB risk if baseline **RBBB** exists)
Permanent Pacemaker (PPM) Rate	**Higher: 8% to 12%** (up to 15–20% in elderly or baseline LBBB)	**Lower: 2% to 5%** (higher if baseline RBBB exists)
Residual Gradient & Repeat SRT Rate	**Higher repeat ablation/myectomy rate: 7% to 12%**	**Very low repeat intervention rate: <1% to 2%**
Long-Term Survival & SCD Risk	Comparable 10-year survival to myectomy in matched cohorts; no proven excess SCD when low alcohol dose (<2 mL) is used	Gold standard for **children, young adults (<40–50 yr), massive LVH (>=30 mm), mid-cavitary obstruction, or intrinsic MV/papillary anomalies**

IV WHEN SURGICAL SEPTAL MYECTOMY IS STRICTLY PREFERRED OVER ASA (CLASS I)

- **Children and Young Adults:** Surgical myectomy is preferred in children and young adults due to superior single-procedure durability and lower lifetime pacemaker dependency.
- **Massive Basal Septal Hypertrophy (30 mm or Greater):** ASA cannot reliably penetrate or thin a >30 mm septum.
- **Concomitant Intrinsic Mitral Valve or Subvalvular Apparatus Abnormalities: Ruptured chordae, intrinsic degenerative mitral prolapse, markedly elongated anterior mitral leaflet (>30 mm) requiring surgical leaflet plication, or anomalous papillary muscle inserting directly into the mitral body/LVOT** (where alcohol ablation of the septum alone will fail to abolish LVOT obstruction).
- **Mid-Cavitary or Apical Obstruction:** Supplied by distal LAD/diagonal branches rather than proximal septal perforators.
- **Concomitant Surgical Lesions:** Multivessel **Coronary Artery Disease** requiring CABG, **Aortic Stenosis**, or **Atrial Fibrillation** warranting surgical Maze + LAA exclusion.
- **Absence of a Suitable Septal Perforator Artery:** Present in 5 to 10 percent of patients (or when MCE demonstrates exclusively non-target RV/papillary muscle perfusion).

V COMPLICATIONS AND THE BUNDLE-BRANCH CROSS-MATCH RULE

- **The Bundle-Branch "Cross-Match" Exam Rule for Complete Heart Block (CHB):**
  - **ASA damages the Right Bundle Branch (producing RBBB in 50 to 60 percent)** because the right bundle courses subendocardially down the right side of the basal interventricular septum supplied by the first septal perforator. Therefore, a patient with **pre-existing baseline LBBB** undergoing ASA has a **>50 to 70 percent risk of developing Complete Heart Block**.
  - **Conversely, Surgical Septal Myectomy damages the Left Bundle Branch (producing LBBB in 40 to 50 percent)** because the surgical excision is performed on the left ventricular subaortic aspect of the septum. Therefore, a patient with **pre-existing baseline RBBB** undergoing Surgical Myectomy has a high risk of developing **Complete Heart Block**.
  - **Other Procedural Complications: LAD dissection or acute anterior wall MI from alcohol reflux** (<1%, prevented by OTW balloon occlusion check), **distant RV/papillary muscle infarction** (prevented by mandatory MCE), **sustained ventricular arrhythmias during the acute 48-hour ischemic phase** (~2–5%, mandating 48 to 72 hours of ICU telemetry), and rare iatrogenic **Ventricular Septal Defect**.

KEY REFERENCES

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