LIST OUT THE PALLIATIVE SURGICAL PROCEDURES IN CHD; CURRENT STATUS

Prepared by **Dr. Sidhartha Mullapudi**, DrNB (Cardiology), MD (General Medicine)
Last reviewed: October 2026

I PATHOPHYSIOLOGICAL PARADIGM AND THE SURGICAL SHIFT

- **Evolution from Universal Palliation to Early Primary Repair:** Historically, two-stage management (initial surgical palliation in infancy followed by corrective intracardiac repair in later childhood) was used across most Congenital Heart Defects (CHD) to avoid the morbidity of neonatal cardiopulmonary bypass. In contemporary practice, **early single-stage Primary Complete Repair** in the neonatal or early infant period (e.g., neonatal arterial switch for d-TGA, truncus arteriosus repair, TAPVC repair, and early infant VSD/TOF repair at 3 to 6 months) is the standard of care for **biventricular hearts**.
- **Contemporary Indications for Palliative Procedures:** Surgical and transcatheter palliation is now reserved for three distinct scenarios:
- **Functionally Univentricular Hearts:** Complex anatomy precluding biventricular repair (HLHS, Tricuspid Atresia, DILV, unbalanced AVSD), requiring the staged **Single-Ventricle Fontan Pathway**.
- **High-Risk Biventricular Bridge:** Premature, very-low-birth-weight (less than 2.0 to 2.5 kg), septic, malnourished, or neurologically compromised neonates (or TOF with anomalous LAD crossing the RVOT / hypoplastic pulmonary arteries) where immediate cardiopulmonary bypass carries prohibitive mortality.
- **Ventricular Retraining:** Preparation of an involuted subpulmonary morphological Left Ventricle prior to an arterial switch or double-switch operation.

II COMPREHENSIVE CLASSIFICATION OF PALLIATIVE PROCEDURES BY HEMODYNAMIC GOAL

A Procedures to Increase Pulmonary Blood Flow (Cyanotic CHD with Reduced Pulmonary Flow)

- **Modified Blalock-Thomas-Taussig (mBTT) Shunt:** Interposition of a **polytetrafluoroethylene (Gore-Tex) tube graft (typically 3.0 to 4.0 mm in neonates)** between the **subclavian or innominate artery** (usually on the side opposite the aortic arch) and the **ipsilateral branch pulmonary artery** (replacing the historical classical Blalock-Taussig shunt, which sacrificed the subclavian artery via direct end-to-side anastomosis).
- **Central Aortopulmonary Shunt (Mee / Melbourne Shunt):** Short Gore-Tex graft or direct anastomosis between the **ascending aorta and main pulmonary artery**; provides high symmetric flow to grow severely hypoplastic, diminutive native central pulmonary arteries in PA-VSD.
- **Sano Shunt (RV-to-PA Conduit):** A valveless or valved **Gore-Tex conduit (5 to 6 mm) connecting the Right Ventricle directly to the Pulmonary Artery bifurcation** (used as part of the Stage 1 Norwood operation for HLHS). Unlike the mBTT shunt, the Sano shunt eliminates **diastolic aortic runoff**, thereby preserving **coronary and systemic diastolic perfusion pressure**, at the cost of a focal right ventriculotomy.
- **Historical Systemic-to-Pulmonary Shunts (Obsolete Due to PA Distortion and High Pulmonary Hypertension Risk): Waterston Shunt** (ascending aorta to right PA) and **Potts Shunt** (descending aorta to left PA). *Important Modern Exception:* The **Reverse Potts Shunt** (surgical or transcatheter connection from the left PA to the descending aorta) has been **revived as a modern palliative decompression procedure for drug-refractory suprasystemic pediatric Idiopathic Pulmonary Arterial Hypertension (IPAH)**, converting suprasystemic RV failure into an Eisenmenger-PDA physiology (preserving normoxic cerebral/coronary perfusion while desaturating only the lower extremities).

B Procedures to Decrease Pulmonary Blood Flow (Pulmonary Overcirculation / Unprotected Pulmonary Bed)

- **Pulmonary Artery Banding (PAB — Muller-Dammann Procedure):** Placement of a constricting circumferential silastic/PTFE band around the **mid-main pulmonary artery** to reduce distal pulmonary artery pressure (targeting less than 30 to 50 percent of systemic pressure) and prevent **Pulmonary Vascular Obstructive Disease (PVOD)** and congestive heart failure.
- **Bilateral Branch Pulmonary Artery Banding:** Placed selectively on the right and left branch PAs as part of the **Hybrid Stage 1 Palliation** for high-risk neonates with **Hypoplastic Left Heart Syndrome (HLHS)** (combined with transcatheter PDA stenting and atrial septostomy).

C Procedures to Bypass the Subpulmonary Ventricle (Venous-to-PA Cavopulmonary Shunts — Single-Ventricle Pathway)

- **Bidirectional Glenn (BDG) Shunt / Hemi-Fontan (Stage 2 Palliation at 4 to 6 Months):** End-to-side anastomosis of the **Superior Vena Cava (SVC) to the Right Pulmonary Artery** (supplying both lungs), unloading the single ventricle after neonatal PVR falls.
- **Kawashima Operation:** Bidirectional cavopulmonary connection performed in single-ventricle patients with **left isomerism (polysplenia) and interrupted IVC with azygos/hemiazygos continuation to the SVC**; routes all systemic venous blood **except hepatic veins** to the pulmonary arteries (later requiring hepatic vein-to-PA incorporation to prevent **pulmonary arteriovenous malformations [PAVMs]**).
- **Fontan Completion / Total Cavopulmonary Connection (TCPC — Stage 3 Palliation at 2 to 4 Years):** Routes **Inferior Vena Cava (IVC) and hepatic venous return** to the pulmonary artery via an **Extracardiac Conduit (18 to 20 mm Gore-Tex)** or **Intra-Atrial Lateral Tunnel**.
- **One-and-a-Half (1.5) Ventricle Repair (Bidirectional Glenn + Intracardiac Repair):** Combines a **Bidirectional Glenn shunt** (unloading upper-body venous return directly to the PAs) with biventricular septation so that a **borderline hypoplastic Right Ventricle** (e.g., in Ebstein anomaly or PA-IVS with bipartite RV) only has to pump IVC venous return (approx. two-thirds of cardiac output).

D Procedures to Enhance Intracardiac Mixing or Retrain Ventricles

- **Surgical Atrial Septectomy (Blalock-Hanlon Closed Septectomy / Open Septectomy):** Largely replaced by transcatheter **Rashkind Balloon Atrial Septostomy** or atrial stenting, though performed surgically during a Stage 1 Norwood operation.
- **Left Ventricular Retraining PAB:** Tightening a PA band on the subpulmonary **morphological Left Ventricle** in late-presenting **d-TGA with intact ventricular septum** or in **ccTGA (L-TGA)** to induce LV hypertrophy (raising LV/RV pressure ratio above 0.7 to 0.8) prior to an arterial switch or **Double Switch (Atrial + Arterial Switch)** operation.

Hemodynamic Goal	Classical / Surgical Palliative Procedure	Modern Transcatheter / Hybrid Counterpart
Increase Pulmonary Flow (Duct-Dependent / Severe TOF)	**Modified Blalock-Thomas-Taussig (mBTT) Shunt**; Central Shunt; **Sano (RV-PA) Shunt**	**Transcatheter PDA Stenting** or **RVOT Stenting**
Decrease Pulmonary Flow (Overcirculation / LV Training)	**Main PA Banding (PAB)** (for multiple "Swiss-cheese" VSDs, single ventricle without PS, or LV retraining in d-TGA/ccTGA)	**Bilateral Branch PA Banding + PDA Stent** (**Hybrid Stage 1** for high-risk HLHS) or transcatheter **Endoluminal PA Flow Restrictors**
Venous Cavopulmonary Bypass (Single-Ventricle Staging)	**Stage 2 Bidirectional Glenn (BDG)** (4–6 mo) -> **Stage 3 Extracardiac / Lateral Tunnel Fontan** (2–4 yr); **1.5-Ventricle Repair**	Transcatheter Fontan completion (in selected pre-prepared Hemi-Fontans)
Increase Intracardiac Mixing	Surgical Atrial Septectomy (Blalock-Hanlon)	**Rashkind Balloon Atrial Septostomy** / Static Balloon / Atrial Septal Stenting
Decompress Suprasystemic RV (Refractory Idiopathic PAH)	**Reverse Potts Shunt** (Left PA to Descending Aorta anastomosis)	**Transcatheter Reverse Potts Shunt** or **Atrial Flow Regulator (AFR)**

III LANDMARK EVIDENCE AND CURRENT DEBATES (2020–2026)

- **mBTT Shunt vs. Sano Shunt in HLHS (SVR Trial — *NEJM* 2010 & 12-Year Follow-up):** The Pediatric Heart Network **Single Ventricle Reconstruction (SVR) Trial** randomized 549 neonates undergoing the Norwood procedure to a **Sano RV-to-PA shunt** versus an **mBTT shunt**. The **Sano shunt significantly improved 12-month transplant-free survival (74 percent vs. 64 percent; p = 0.01)** due to lower interstage diastolic steal and sudden arrest, though by 6 to 12 years of follow-up, overall transplant-free survival equalized between the two groups with higher catheter reinterventions in the Sano cohort.
- **Transcatheter PDA Stenting vs. Surgical mBTT Shunt:** Large multicenter comparative registries (Glatz et al., *Circulation* 2018; Bentham et al., *Circulation* 2018) demonstrate that in neonates with duct-dependent pulmonary blood flow, **PDA stenting results in lower procedural complications, shorter ICU stay, less diuretic use, and larger, more symmetrical branch pulmonary artery growth** compared with surgical mBTT shunting, at the trade-off of higher planned/unplanned catheter re-interventions for stent redilation.
- **Modern Restricted Indications for Pulmonary Artery Banding:** Isolated single VSDs are closed primarily in infancy; today, **PAB** is reserved for (1) **multiple apical muscular ("Swiss-cheese") VSDs**, (2) **unbalanced AVSD or single ventricle with unrestricted pulmonary blood flow**, (3) critically ill neonates with intracranial hemorrhage or necrotizing enterocolitis contraindicating cardiopulmonary bypass, and (4) **morphological LV retraining in late-presenting d-TGA or ccTGA**.

KEY REFERENCES

- **Ohye RG, Sleeper LA, Mahony L, et al. (Pediatric Heart Network Investigators):** Comparison of shunt types in the Norwood procedure for single-ventricle lesions (Single Ventricle Reconstruction [SVR] Trial), *New England Journal of Medicine*, 2010.
- **Glatz AC, Petit CJ, Goldstein BH, et al.:** Comparison Between Patent Ductus Arteriosus Stent and Modified Blalock-Taussig Shunt as Palliation for Infants With Ductal-Dependent Pulmonary Blood Flow, *Circulation*, 2018.
- **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.