AORTIC DISSECTION CLASSIFICATION; ADVANCES IN MANAGEMENT

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I INTRODUCTION AND PATHOPHYSIOLOGY

- **Definition:** A catastrophic cardiovascular emergency characterized by a tear in the aortic intima that allows pulsatile blood to track into the media, creating a true lumen and a false lumen separated by an intimal flap.
- **The Hemodynamic Driver:** Propagation of the dissection tear is directly driven by **dP/dt** (the rate of rise of left ventricular systolic pressure / shear stress) and absolute systolic blood pressure.

II CLASSIFICATION SYSTEMS AND RISK STRATIFICATION

- **Stanford Classification (Functionally Guides Management):**
  - **Type A:** Involves the **Ascending Aorta**, regardless of the anatomical site of the primary intimal tear.
  - **Type B:** Does **not** involve the Ascending Aorta (originates distal to the left subclavian artery).
  - **DeBakey Classification (Anatomical Origin and Extent):**
  - **Type I:** Originates in the ascending aorta and propagates to the aortic arch and descending aorta.
  - **Type II:** Confined strictly to the ascending aorta.
  - **Type IIIa:** Originates in the descending aorta and is confined strictly to the thoracic aorta above the diaphragm.
  - **Type IIIb:** Originates in the descending aorta and extends below the diaphragm into the abdominal aorta.
  - **Modern ESC/AHA Classification Addition:**
  - **Non-A Non-B Dissection:** Involves the **aortic arch** (either by retrograde extension from the descending aorta or an arch entry tear) while strictly sparing the ascending aorta; managed similarly to complicated Type B dissection or via hybrid arch repair.
  - **Type B Clinical Risk Stratification:**
  - **Uncomplicated Type B:** Pain resolves, blood pressure is controlled, and there is no evidence of rupture or end-organ ischemia.
  - **High-Risk Uncomplicated Type B:** Uncomplicated presentation but with high-risk anatomical features on CTA—such as initial **false lumen diameter greater than 22 mm**, **primary entry tear greater than 10 mm**, or **partial false lumen thrombosis**.
  - **Complicated Type B:** Characterized by refractory pain, rapid aortic expansion (greater than 5 mm), impending/contained rupture, or **Malperfusion Syndrome** (visceral/mesenteric, renal, spinal cord, or lower-extremity ischemia).

III DIAGNOSTIC ALGORITHM

- **Biochemical Markers: D-dimer** is highly sensitive; a level **less than 500 ng/mL** helps rule out acute aortic dissection in patients with low-to-intermediate pre-test probability (Class IIa).
- **Imaging Modalities:**
  - **CT Angiography (CTA) of the Entire Aorta (Chest, Abdomen, Pelvis):** The **Class I gold standard** for rapid diagnosis, tear classification, branch vessel assessment, and pre-procedural planning.
  - **Transesophageal Echocardiography (TEE):** Reserved strictly for hemodynamically unstable patients in the emergency room or operating theater.
  - **Magnetic Resonance Angiography (MRA):** Preferred for chronic long-term serial surveillance to minimize cumulative radiation and iodinated contrast exposure.

IV ACUTE MEDICAL AND DEFINITIVE MANAGEMENT STRATEGIES

A Acute Medical Stabilization (Anti-Impulse Therapy — Class I)

- **Hemodynamic Targets:** Rapidly reduce **Heart Rate to less than 60 bpm** and **Systolic Blood Pressure to 100 to 120 mmHg**.
- **Step 1 — Intravenous Beta-Blockade (First-Line):** Administer **Esmolol** or **Labetalol** intravenously to simultaneously lower heart rate and left ventricular **dP/dt (shear stress)**.
- **Step 2 — Intravenous Vasodilators (Second-Line Only):** If systolic blood pressure remains elevated *after* adequate beta-blockade is achieved, add **Intravenous Sodium Nitroprusside** or **Nicardipine**.
- **Critical Clinical Rule:** Never administer a pure vasodilator (such as Nitroprusside or Hydralazine) prior to beta-blockade, as it triggers **reflex sympathetic tachycardia**, markedly increasing dP/dt and propagating the dissection flap.

B Definitive Surgical and Endovascular Management

Dissection Category	Guideline Class	Definitive Management Strategy
Stanford Type A (DeBakey I & II)	**Class I, LOE B**	**Emergency Open Surgical Repair:** Ascending aortic replacement, resection of primary tear, **Right Axillary Artery Cannulation** (antegrade cerebral perfusion), **Valve-Sparing Root Replacement (David)** or Bentall, and **Frozen Elephant Trunk (FET)** for arch/descending extension
Complicated Stanford Type B (Malperfusion / Rupture)	**Class I, LOE B**	**Emergency TEVAR (Thoracic Endovascular Aortic Repair)** to cover the primary entry tear, expand the true lumen, and restore branch perfusion
High-Risk Uncomplicated Type B (False lumen >22 mm, Tear >10 mm)	**Class IIa**	**Pre-emptive / Subacute TEVAR** plus optimal medical therapy to induce false lumen thrombosis and prevent late aneurysmal degeneration (**INSTEAD-XL & ADSORB Trials**)
Low-Risk Uncomplicated Type B	**Class I**	**Optimal Medical Therapy (OMT)** with strict anti-impulse BP control and serial CTA/MRA surveillance

V LONG-TERM MANAGEMENT AND SURVEILLANCE

- **Lifelong Blood Pressure Target:** Maintain blood pressure **less than 130/80 mmHg** (ESC 2024; SBP below 120 mmHg in the acute phase) to minimize chronic wall stress.
- **Disease-Modifying Pharmacotherapy:** Lifelong **Beta-blockers** combined with **Angiotensin Receptor Blockers (Losartan or Irbesartan)**, which inhibit **Transforming Growth Factor-beta (TGF-beta)** signaling in the aortic media and may slow secondary aneurysmal expansion (evidence mainly from Marfan syndrome).
- **Surveillance Imaging Schedule (Class I):** Perform CTA or MRA of the entire aorta at **1 month, 3 months, 6 months, 12 months**, and **annually thereafter for life** (dedicated multidisciplinary **Aortic Clinics** improve compliance; expansion greater than 5 mm/year triggers re-intervention).
- **Lifestyle Restrictions:** Strict avoidance of competitive contact sports, isometric exercises, and heavy weightlifting (Class IIa).

VI RECENT ADVANCES AND LANDMARK TRIALS

- **Surgical Innovations in Type A Dissection:**
  - **Frozen Elephant Trunk (FET):** Single-stage hybrid operation combining open surgical replacement of the ascending aorta and arch with antegrade deployment of a stented endograft trunk into the descending aorta, expanding the true lumen and obliterating the proximal false lumen.
  - **Valve-Sparing Aortic Root Replacement (VSRR / David Procedure):** Re-suspends the native aortic valve inside a synthetic graft in young patients, avoiding lifelong anticoagulation.
  - **Right Axillary Artery Cannulation:** Replaces retrograde femoral cannulation during cardiopulmonary bypass, preventing retrograde atheroembolic stroke.
  - **Endovascular Innovations in Type B Dissection:**
  - **INSTEAD-XL and ADSORB Trials:** Demonstrated that adding TEVAR to medical therapy in uncomplicated Type B dissection promotes false lumen thrombosis and true lumen recovery (ADSORB, 1 year) and improved 5-year aorta-specific survival (INSTEAD-XL).
  - **The FLIRT Concept (False Lumen Interventions to Promote Remodeling and Thrombosis):** Uses techniques such as the **"Candy-Plug" occluder** or coil embolization inside a persistently perfused distal false lumen to force complete thrombosis.
  - **Fenestrated and Branched TEVAR (F-TEVAR / B-TEVAR):** Custom stent-grafts with fenestrations or side-branches that allow endovascular sealing across the visceral and renal arteries.
  - **18F-FDG PET-CT ("The Vulnerable Aorta"):** Detects active macrophage-driven inflammation in the false lumen wall, an investigational predictor of rapid expansion.

KEY REFERENCES

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