Management of the aortic arch in acute non-A non-B aortic dissection

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Challenges in classification and nomenclature

For decades, the Stanford classification has served as the primary framework for clinical decision-making, dividing dissections into types A and B based on the involvement of the ascending aorta. Although this binary system has practical utility, it oversimplifies the anatomical complexity of the disease and fails to reflect the full spectrum of dissection patterns encountered in contemporary practice. The evolution of surgical and endovascular techniques and the growing body of evidence on treatment outcomes across different aortic dissection subtypes have highlighted the need for more precise characterization of dissection patterns, particularly in cases involving the aortic arch that do not clearly fit into type A or type B (1).

Even the recent Society of Thoracic Surgeons (STS) and Society for Vascular Surgery (SVS) guidelines (2) classify dissections primarily according to the location of the entry tear as type A or type B, although this classification is supplemented by a descriptive approach using Ishimaru zones (3) to define the proximal and distal extent of the lesion. The latest update (from 2022) of the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines on aortic disease (4) does not attempt to classify dissections that do not fit the A and B types.

In contrast, guidelines from the European Association for Cardio-Thoracic Surgery (EACTS) suggest an updated framework that includes type, entry point, and malperfusion status (5). Like the Stanford classification, this method focuses on the overall extent of the dissection with respect to the location of the primary entry tear. Notably, it officially introduces a separate category for dissections involving the aortic arch and the descending aorta, but not the ascending aorta, called *non-A non-B aortic dissection*, which has not been widely adopted in North American guidelines (5).

Distinct clinical and anatomical features of non-A non-B aortic dissection

Non-A non-B dissection represents a distinct and clinically challenging entity. Although these dissections are often managed similarly to type B dissections, accumulating evidence suggests that they follow a more complex clinical course and more frequently require earlier and more aggressive intervention (1). Non-A non-B aortic dissection accounts for approximately 10% of all acute aortic dissections. Affected patients represent a unique demographic, tending to be younger than those with type A and type B dissections and having an in-hospital mortality rate of around 10% (1,6). These dissections occur most commonly along the convexity of the arch, with entry tears

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frequently located near the innominate and left common carotid arteries and less commonly originating from the left vertebral artery (6). The innominate artery sometimes acts as a relative barrier, limiting retrograde extension into the ascending aorta and thereby confining the dissection to the arch (7).

An overwhelming proportion of these patients require urgent or emergency intervention: approximately one-third undergo emergency aortic repair, while most of the remaining two-thirds require intervention within 2 weeks of dissection onset (1,7,8). Dissections with a primary entry tear located in the aortic arch tend to follow a more complicated clinical course than those with a descending-entry tear and retrograde extension (8). Compared with type A and B dissections, these dissections more frequently necessitate aortic arch replacement, reflecting their higher risk of rupture and end-organ malperfusion (6). Importantly, a purely medical strategy—which is often the first-line approach in type B dissection according to the guidelines—is insufficient in this group, as medically managed patients have significantly higher 30-day mortality (7). Even after repair, non-A non-B dissections are associated with higher rates of aortic reintervention than type A dissections and poorer mid-term survival at 2 years than type B dissections (7,9).

Management of non-A non-B dissection: open surgical versus endovascular approaches

The management strategies for type A and type B aortic dissections are well established, with type A requiring prompt surgical intervention and type B being generally managed with medical and endovascular therapies as first-line treatment (4,5,10). In contrast, the optimal management of non-A non-B dissections remains uncertain. Although some of these lesions behave similarly to complicated type B dissections and may be amenable to endovascular intervention, others, particularly those with a primary tear in the aortic arch, carry a higher risk of rupture, malperfusion, and early disease progression; thus, they often require a more aggressive surgical approach (11,12).

The involvement of the aortic arch beyond the left subclavian artery has emerged as a key marker of instability in non-A non-B dissections, irrespective of the location of the primary entry tear (12). As per the International Registry of Acute Aortic Dissection, non-A non-B dissections can be further divided into two distinct subtypes based on the location of the primary entry tear: arch-entry and descending-entry tear types, which are reported to differ significantly in their clinical course and therefore should not be approached as a homogenous entity (9,13,14). This distinction has important implications for treatment planning, particularly with respect to the effectiveness of thoracic endovascular aortic repair (TEVAR). In descending-entry dissections, TEVAR achieves high rates of entry tear closure, approaching 90%, and restores true-lumen flow (6). In contrast, entry tear closure rates are reported to be as low as 62% in arch-entry dissections; this lower success rate is associated with a greater need for secondary aortic intervention and higher in-hospital mortality rates among these patients (6,8). These findings suggest that although TEVAR is highly effective in treating descending-entry non-A non-B dissection, its reliability is limited in arch-entry disease. This is primarily due to challenges in consistently excluding the proximal entry tear and establishing an adequate disease-free landing zone without compromising the supra-aortic branches, often resulting in endoleak and an elevated risk of retrograde type A aortic dissection (15). Hence, arch-entry dissections more often require more extensive, arch-based repair strategies to achieve durable outcomes.

In this context, aortic arch dissection should not be conceptualized merely as an intimal tear permitting blood entry into the medial layer, but rather as the visible manifestation of a deeper and more diffuse disease process involving intrinsic dysfunction of the medial and adventitial layers, particularly the vasa vasorum, which are critical for aortic wall integrity (16,17). Consequently, the aortic tissue in arch-involving dissections is intrinsically diseased, and intimal disruption can be better understood as the final event in a cascade of wall degeneration rather than as the primary pathology (18). For that reason, although TEVAR can effectively exclude the entry tear, it does not address the underlying pathological substrate of the aortic wall. Therefore, surgical strategies incorporating total arch reconstruction, such as the frozen elephant trunk (FET), enable the resection of the diseased segment and restoration of a more physiologically stable aortic architecture, offering a more definitive and durable solution in arch-entry dissections.

Building on this pathophysiological rationale, the FET has been consistently associated with high rates of early false-lumen thrombosis—approximately 85% within the first 3 months and increasing to nearly 90% by 6 to 12 months—which supports the concept that aortic remodeling begins early after intervention and progresses over time (19). This early and sustained thrombosis, together with progressive aortic remodeling, represents a key determinant of long-term stability in dissection disease (20,21). The enhanced durability, however, comes at the expense of greater perioperative burden, including higher rates of renal dysfunction, greater transfusion requirements, and prolonged recovery related to cardiopulmonary bypass and extended hospital stay (19-22). As highlighted by Roselli *et al.*, management reflects an inherent trade-off between early procedural risk and long-term durability (21).

Comparative clinical outcome series further contextualize these trade-offs, demonstrating comparable early and long-term mortality between endovascular and open surgical approaches, with reported early mortality ranging from 2% to 7% across published series (15,19-22). However, important differences emerge in durability and complication profiles. FET is associated with a substantially lower rate of early endoleak than endovascular approaches (6.1% *vs.* 33.3%), reflecting more effective proximal tear exclusion (15). Reintervention rates similarly favor FET, although variability exists across studies, with reported rates ranging from 2.6% to 17% in FET patients compared with 5.7% to 28% in endovascular cohorts (21,22). Importantly, the stable distal landing zone established with FET facilitates safer and more effective secondary endovascular interventions when required. These findings are further supported by long-term data reported by Tian *et al.*, whose 5-year outcomes included greater freedom from aortic-related late events (89.5% *vs.* 74.2%) and better overall survival (97% *vs.* 91%) with open surgical management (15).

Neurologic complications remain a major concern for both approaches. Cerebrovascular event rates range from 2.5% to 20% after FET and from 1.1% to 1.4% after TEVAR, whereas spinal cord ischemia is reported in up to 20% of FET cases and in 0% to 10.6% of TEVAR cases, with permanent deficits occurring in 0% to 5.1% (15,19-24). Although neurologic outcomes appear broadly comparable, FET may provide superior long-term durability by promoting favorable aortic remodeling and reducing secondary aortic interventions.

The branched stented anastomosis frozen elephant trunk repair (B-SAFER) technique represents a novel hybrid evolution of extended arch repair aimed at mitigating the limitations of conventional FET by incorporating a branched stented anastomosis approach that enables extended repair while reducing operative complexity and physiological burden. Early data suggest that the technique is safe, reproducible, and broadly applicable across a range of aortic pathologies in both elective and emergency cases (25). Although most commonly applied in acute type A dissections, B-SAFER may serve as a valuable alternative in arch-involving non-A non-B dissections, offering a balance between the durability of FET and a reduction in operative burden.

In conclusion, accumulating evidence suggests that entry tear location, specifically distinguishing arch-entry from descending-entry dissections, has important implications for both underlying pathophysiology and optimal management strategy. Many existing studies have heterogeneous cohorts, often including complicated type B dissections or cases with retrograde extension into the ascending aorta, which do not meet the definition of true non-A non-B pathology and thus confound interpretation. This lack of differentiation results in heterogeneous data that inconsistently support either TEVAR or FET without clear contextual interpretation, contributing to inconsistent conclusions across studies and making it difficult to draw definitive comparisons between treatment approaches.

Ultimately, advancing the management of non-A non-B dissection will require adopting more precise, pathology-based classification systems that better reflect the underlying disease process and guide individualized therapeutic decision-making.

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