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Acute type A aortic dissection: when not to operate, a review

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Abstract
Acute type A aortic dissection (ATAAD) is a surgical emergency with a nonoperative mortality rate of up to 1% per hour and an operative mortality rate as high as 24%. Therefore, evaluation of comorbidities and patient presentation characteristics prompts a pause for risk stratification before proceeding to the operating room, as emergent surgery may not always be the optimal approach. This comprehensive review explores key considerations in ATAAD management, emphasizing the need for nuanced decision making, by considering medical management and delayed surgery as an alternative management approach for high-risk populations such as the frail or patients who have a history of cardiac surgery. Beyond the immediate threat of aortic rupture, organ malperfusion stands out as the most feared complication of ATAAD, also elevating perioperative risk significantly. In such cases, careful assessment of patient's hemodynamic status is paramount. For stable patients, a thorough preoperative strategy and multidisciplinary discussions are encouraged. Notably, the advent of endovascular techniques provides viable lower-risk alternatives to the traditional open approach. The consequences of ATAAD surgical intervention extend beyond the immediate procedural concerns, with a substantial impact on the patient's overall function. Prioritizing patient-centered care becomes imperative in aligning management with individual goals of care. This review seeks to provide insights into these considerations by offering a stepwise approach to patient-centered decision-making in ATAAD management.

Keywords: Acute type A aortic dissection, aortic surgery, dissection repair, medical management, frailty, organ malperfusion, patient-centered care, previous cardiac surgery

INTRODUCTION

Acute type A aortic dissection (ATAAD) is a surgical emergency that affects approximately 10,000 patients per year in the United States alone[1] and, if left untreated, is associated with serious complications including mortality. The estimated incidence is likely an underestimation; multiple studies have indicated that the incidence of ATAAD is higher than initially believed[2,3] due to a significant number of patients who never make it to the hospital and, as a result, are not properly diagnosed with ATAAD. In fact, a post-mortem autopsy study revealed ATAAD to be the cause of death in 7% of patients initially presumed to have succumbed to cardiopulmonary arrest[4]. Prompt surgical intervention is typically warranted for ATAAD, given that the mortality rate in patients managed nonoperatively can be as high as 1%-2% per hour during the first 48 h[5,6]. However, despite advancements in technique and perioperative management[7], surgical intervention itself can have a mortality rate of up to 24%[8-12]. Therefore, the decision on whether to proceed with emergent operative repair depends on weighing a patient's acute surgical risk against the known high risk associated with nonoperative management. Identifying surgical risk factors is critical in providing guidance for clinical decision making during these emergent scenarios. The aim of this review is to inform treatment decisions in this complex patient group by highlighting elements to consider when deciding whether ATAAD should be operated on. The importance of patient stratification should be emphasized, and in certain scenarios, medical treatment, or optimization prior to surgery involving pain control, anti-impulse therapy, antihypertensive therapy through vasodilatation, and blockage of the sympathetic beta response should be considered.

FRAILTY AND THE ELDERLY

The aging population is rapidly increasing and the presentation of ATAAD in octogenarians is not infrequent[13]. Frailty, identified as an independent predictor of late mortality in patients undergoing surgical repair for ATAAD[14], presents a complex challenge. Although frailty scoring systems have been developed and implemented in medicine[8,15,16], their use still lags within the field of cardiac surgery. For instance, ATAAD-specific scores, such as the German Registry for Acute Type A Aortic Dissection (GERAADA) score, exclude frailty[17,18] consideration when assessing mortality, leaving clinicians to rely on an "eyeball test" or functional status inquiries with patients and their families[19,20]. The emergent nature of aortic dissections complicates frailty assessments due to urgency and symptoms, often leading to age being used as a proxy for frailty[8] .

While surgery is generally advised for ATAAD, its expected benefits may be diminished in elderly patients, a demographic inherently at higher risk. A study leveraging the International Registry of Acute Aortic Dissection (IRAD) found that surgery did not offer a survival benefit compared to medical management in octogenarian patients presenting with ATAAD[21]. Similarly, a systematic review focusing on octogenarian patients revealed a twofold higher likelihood of short-term (30-day or in-hospital) mortality following surgery for ATAAD compared to non-octogenarians[22] [Figure 1]. These results were comparable to previously published systematic reviews[23,24].

Several factors contribute to the higher perioperative mortality observed in elderly ATAAD patients. Elderly patients typically exhibit fewer symptoms[22,25], leading to later and more complicated dissections. The elderly population is also prone to complications on admission, such as cardiac tamponade and prolonged intubation[25,26]. Ultimately, elderly patients may have higher perioperative mortality simply by having less reserve than their younger counterparts.

Importantly, frail elderly patients with concomitant malperfusion issues face even worse prognostic outcomes, exacerbating the challenges associated with frailty. Cerebral degenerative diseases like dementia

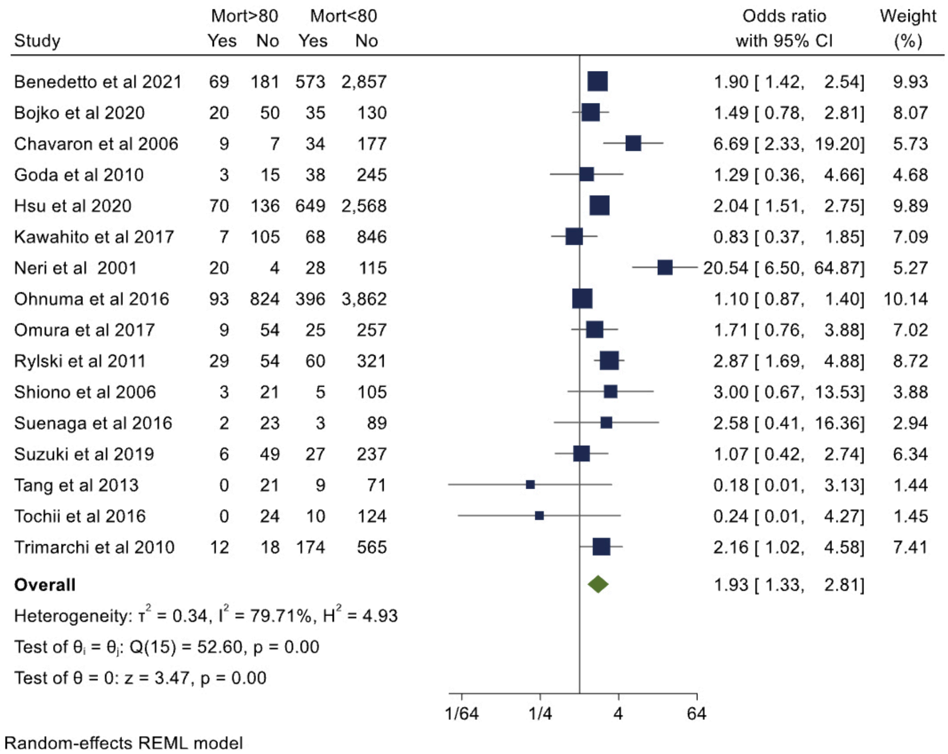

Figure 1. Higher risk of short-term mortality for octogenarian cohorts compared to their non-octogenarian counterparts (Reproduced from Eranki *et al.*[22], with permission from BMC).

and preexisting immobility further compound the complexity of cases involving frail individuals. Addressing these multifactorial issues is crucial for a comprehensive understanding of the patient's condition and the formulation of an appropriate treatment plan. This should be taken into consideration during the decision-making process for surgical interventions in this vulnerable population.

Studies[27,28] highlight surgical treatment as a reasonable option, associated with lower all-cause in-hospital mortality compared to conservative management[29]. However, this benefit comes at the expense of increased comorbidities, prolonged hospital stays, and a higher incidence of stroke. Literature suggests that a more aggressive approach during ATAAD repair may lead to improved long-term survival and lower risk for reoperation[30]. Nonetheless, for high-risk populations such as frail patients, a "less invasive quick replacement"[27] becomes essential, particularly in the context of prolonged surgeries for octogenarians.

Patients undergoing surgical treatment also present with significantly lower Barthel Index (BI) scores[29], indicating a diminished ability to perform daily activities, necessitating additional support upon discharge[29,31]. This highlights the necessity for a comprehensive discussion with patients, considering potential impacts on independence, the need for extensive support, and the potential compromise of their quality of life.

While the overall outcomes for elderly patients may not be as favorable as for younger patients, individual factors such as performance status and independence with activities of daily living (ADLs) play a crucial role in determining the appropriateness of surgery. Our previous study by Percy *et al.*. emphasized that frailty, rather than age alone, is a critical predictor of mortality in patients undergoing aortic surgery[32].

In summary, the decision for emergency surgery in elderly patients with ATAAD remains controversial. Acknowledging the higher short-term and in-hospital mortality compared to younger patients after ATAAD[25], surgical treatment may still provide better outcomes than conservative management. However, the decision to offer surgery requires a frank discussion about expected surgical complications, their impact on the patient's global function, independence, and alignment with individual goals of care. Recognizing the complexities of assessing frailty in emergent scenarios emphasizes the need for a nuanced, individualized approach, where frailty assessment takes precedence over age alone in guiding treatment decisions.

PREVIOUS CARDIAC SURGERY

Chest re-entry following a previous cardiac surgery (PCS) presents a range of potential complications that contribute to elevated operative mortality. A study employing propensity matching revealed higher observed mortality rates in patients undergoing reoperative surgery compared to those with a virgin chest (8.37% *vs*. 6.07%, $P = 0.01$)[33]. The adherence of the heart to the posterior table of the sternum raises the risk of right ventricular injury. Additionally, individuals with a history of coronary artery bypass grafting (CABG) face the risk of graft injury upon re-entry[34], along with heightened difficulty in achieving myocardial protection, necessitating exposure of the left internal mammary artery amidst extensive adhesions.

Patients with previous cardiac surgery often present with more comorbidities on admission and experience longer cardiopulmonary bypass and aortic cross-clamp times during the reoperation[35], contributing to a higher rate of perioperative complications. It is important to remember that patients with PCS may have different symptoms during presentation due to cardiac sympathetic nervous system denervation during their prior operation[36], potentially leading to delayed diagnosis. Patients who are in this category should be worked up with this caveat in mind.

The question of whether PCS itself is an independent risk factor for patients undergoing surgery for ATAAD is still under debate. Multiple studies have shown that major adverse events are more frequent in patients with previous chest entry[37,38]. Those with previous cardiac surgery had worse medium-term survival (51.7% *vs*. 71.2% at 5 years, $P = 0.020$) [Figure 2][39]. Likewise, the survival rates within the 5- and 10-year periods were significantly lower in patients who had previous cardiac surgery compared to those who had not (56% *vs*. 72%, $P = 0.004$)[35].

Despite some studies suggesting that patients with ATAAD who have undergone PCS may have adhesions that potentially offer a protective effect against tamponade and aortic rupture[37,40,41], the data are not consistent. In a large, contemporary multicenter study, Bjurbom *et al*. found no evidence of previous cardiac surgery being an independent risk factor for mortality after ATAAD repair[39]. However, the PCS group encountered more major adverse events including 30-day mortality, perioperative stroke, postoperative cardiac arrest, or de novo dialysis[39]. Likewise, in a recently published multicenter study, patients with previous PCS undergoing cardiac surgery had similar early and long-term outcomes compared with those of virgin entry[42], though with a higher incidence of surgical revision for bleeding[42].

Yang *et al*. proposed offering surgery to these patients on an elective basis if they are hemodynamically stable at presentation. They described improved mortality when performing ATAAD repair on hemodynamically stable patients who had undergone PCS on an elective basis rather than urgently (16.7% *vs*. 30%)[43].

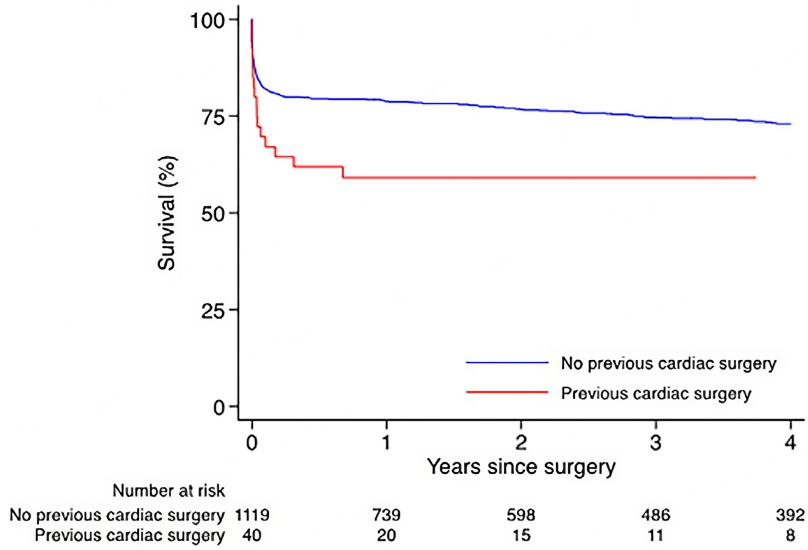

Figure 2. Acute type A aortic dissection survival after surgery comparing patients with (red line) and without previous cardiac surgery (blue line [P = 0.020]). (Reproduced from Bjurbom and colleagues, with permission from Elsevier).

Considering these factors, when providing surgical management for this high-risk population, it is crucial to thoroughly assess the details of prior surgeries and their maintenance. For instance, individuals who have undergone CABG should ideally undergo left heart catheterization to inspect the grafts thoroughly prior to aortic repair. Similarly, for patients who have undergone valve surgery, careful attention to the previously managed valve is imperative. This comprehensive approach ensures a thorough evaluation, addressing specific considerations related to the patient's surgical history and optimizing the overall management strategy. Additionally, these meticulous assessments are of paramount importance as they may also influence the decision on whether concomitant surgery is required during the repair of ATAAD.

In summary, patients with PCS presenting with ATAAD should be carefully considered for surgery. Surgical planning[44], including strategies for obtaining imaging preoperatively or establishing cardiopulmonary bypass prior to re-entry[34], should be thorough as there is potential for significant injury upon re-entry. Lastly, there may be cases that can be optimized prior to surgery and wait for a maximum of 2-3 days, especially when patients are hemodynamically stable at the time of presentation.

ORGAN MALPERFUSION

ATAAD may result in inadequate blood supply to vital organs, termed malperfusion. If sufficient blood supply is not reestablished within a suitable time period, it may result in end-organ ischemia and, in the presence of signs, symptoms and radiographic evidence of malperfusion, constitute a malperfusion syndrome[45]. Besides aortic rupture, malperfusion is the most feared potential complication of ATAAD. It affects about 20%-50% of patients and has been quoted to have perioperative mortality as high as 29%-89%[46]. Furthermore, malperfusion syndrome has been shown to be an independent risk factor for in-hospital mortality for ATAAD patients. In a recently published meta-analysis, malperfusion was identified as a significant preoperative risk factor for early death after ATAAD surgical repair [OR 3.45, 95%CI:(2.24, 5.31)][46].

Malperfusion in ATAAD can occur through various mechanisms, including the collapse of the true aortic lumen, occlusion of vessel branch ostia by intimal dissection flap, or thrombosis of the branch, all of which influence the timing and approach of intervention[47]. Further, occlusion may be dynamic or static. Dynamic occlusion is the result of the intimal flap reversibly and intermittently prohibiting blood flow to a vessel branch, either due to collapse of the true aortic lumen or prolapse of the intimal flap into the vessel branch. Conversely, static occlusion may occur when the dissection extends into the vessel branch, often causing thrombosis[48]. The former may be reversed with the reestablishment of antegrade flow through the true lumen, whereas the latter will remain occluded without intervention on the vessel branch itself.

There are three primary approaches to address malperfusion in ATAAD: (1) early open surgical repair of the ascending aorta; (2) early endovascular reperfusion via distal fenestration or stenting followed by open surgical repair; and (3) early thoracic endovascular aortic repair (TEVAR) followed by open surgical repair, which is emerging as a promising option. In general, early open surgical repair is favored in cases where malperfusion is due to dynamic occlusion, whereas early endovascular reperfusion may be more strongly considered in cases with static occlusion or treatment delays[45]. The descending and abdominal aorta may be further intervened upon endovascularly via TEVAR and its variations Provisional Extension To Induce Complete Attachment (PETTICOAT) and Stent-Assisted Balloon-Induced Intimal Disruption and Relamination of Aortic Dissection (STABILISE), where the former supplements the proximal stent graft with a distal bare metal stent, and the latter additionally expands endovascular balloons within the stent graft to obliterate the false lumen[49].

By the mechanisms described above, ATAAD can affect various vessel beds, potentially leading to any combination of cerebral, spinal, coronary, renal, mesenteric, and extremity malperfusion. Each form of malperfusion is approached differently, due to varying risks of morbidity and mortality, but the ideal management of each remains uncertain. Nonetheless, early open surgical repair of the ascending aorta is typically preferred for dynamic cerebral, spinal, coronary, and extremity malperfusion, and additional interventions, such as carotid replacement, coronary ostial repair or bypass grafting and brachial or femoral shunting, may be pursued as needed during surgery to reestablish end-organ perfusion[48]. However, early non-surgical reperfusion techniques can be considered in patients with static occlusion or as a temporary bridge to surgery, including carotid artery stenting, percutaneous coronary intervention, and iliac stenting[48].

There exists, however, more debate as to the appropriate reperfusion strategy in cases of mesenteric malperfusion, and indeed, management options are continuing to evolve. Mesenteric malperfusion is associated with particularly high mortality, as high as 70% to 100%[50], and consequently poses a clinical dilemma on whether to approach reperfusion via immediate central aortic repair, early fenestration or stenting of the descending aortic flap, or, more recently, performing TEVAR first and reassessing after reperfusion. While medical management of mesenteric malperfusion may take the form of preoperative volume resuscitation, with careful impulse control, medical therapy alone without intervention carries an in-hospital mortality of 95%[51]. For centers without the capacity to deliver any of the definitive interventions for visceral malperfusion, it is reasonable to initiate temporizing medical management strategies and transfer patients to a comprehensive aortic center[52].

Open central aortic repair has been the *de facto* treatment approach for ATAAD with mesenteric malperfusion, as it reduces the risk of aortic rupture and can also reverse dynamic mesenteric occlusion. However, given the high mortality associated with mesenteric malperfusion, intravascular fenestration and stenting followed by definitive open surgical procedure, prioritizing end-organ perfusion restoration and resolution of static occlusion is often considered[45,53]. In fact, for patients with mesenteric malperfusion who undergo early fenestration and stenting, in-hospital and long-term survival after open repair has been found to be equivalent to patients who did not present with malperfusion syndrome at all[54,55]. This approach is particularly important when deep hypothermic circulatory arrest is contemplated, which poses an even greater insult via enduring visceral ischemia. Notably, if central repair is addressed first, one must consider the possibility of reperfusion syndrome when flow is restored to true lumen.

More recently, promising results have been demonstrated for a TEVAR-first approach, in which the true lumen of the descending aorta and occluded vessel branches are stented open prior to surgical repair of the ascending aorta. One institution reports 30% mortality after TEVAR-first (n = 3 out of 10) for patients with ATAAD and mesenteric malperfusion, compared to 69.2% mortality after ascending/arch repair first, though notably, an additional three patients in the TEVAR-first group died before aortic replacement and this group was likely biased towards more hemodynamically stable patients[56]. Another institution reported a 2-year survival rate of 71.8% with this approach in patients with ATAAD, of whom 44% had visceral malperfusion[57].

Thoughtful deliberation should be had before considering patients with malperfusion for open repair in the setting of ATAAD because of such high perioperative risk. In 2022, the American College of Cardiology and American Heart Association guidelines recommended immediate surgical repair of the ascending aorta for patients with renal, mesenteric, or lower extremity malperfusion[47]. However, for patients presenting with clinically significant signs of mesenteric malperfusion in particular, it is reasonable to pursue either immediate surgical repair of the ascending aorta or immediate endovascular or surgical mesenteric revascularization followed by ascending aortic repair[47].

PATIENT-CENTERED CARE

Recently, there has been an increased interest in the integration of palliative care involvement for critical illness requiring surgery. Nevertheless, it is still relatively underused. Additionally, palliative care involvement during emergency situations such as the presentation of ATAAD has its limitations.

Hesitation of palliative care involvement has been particularly pronounced within the field of cardiothoracic surgery. The focus of cardiac surgery has historically been recovery and not palliation; hence, the hesitation of palliative care team involvement is likely due to the conflict in terminology[58]. While cardiac surgeons attempt to restore a patient's life by offering surgery, the "palliative" term may give a negative connotation and make surgeons feel uneasy about involving this multidisciplinary team. However, a frank conversation of the best and worst possible clinical outcomes is warranted to facilitate effective patient decision making, especially because surgeons have been known to be particularly optimistic[58] about potential surgical outcomes.

Multidisciplinary palliative care teams may not be immediately available during emergent situations. Hence, we must do better as surgeons and be able to conduct these conversations ourselves. As proposed by Nakagawa, palliative care conversations will address both spiritual and physiologic stress, reduce symptom burden, and provide emotional support to all involved[59].

PATIENT REFUSAL OF BLOOD PRODUCTS

Patients who suffer ATAAD typically have higher blood product transfusion requirements, likely due to the length of surgery and the use of protective hypothermia[60]. Approximately 3.7% of patients experience uncontrollable hemorrhage, constituting 20% of the total fatalities in this population[61]. Consequently, some surgeons would consider the refusal of blood product transfusion as a contraindication for ATAAD repair. If the patient does not consent to blood transfusion, the risk of perioperative mortality will likely increase, and consideration of medical management or delay in surgery instead may be pursued. Nevertheless, one should not assume patients' preferences regarding blood product transfusion based on their other beliefs, especially given that patients may hold different opinions about different types of blood products.

BRIEF WORD ON SCORING SYSTEMS FOR ATAAD

As previously mentioned, open surgical repair, despite being considered the gold standard for ATAAD, still comes with a notable risk of operative mortality. Consequently, several scoring models have been developed to predict risk factors for ATAAD patients undergoing surgical repair. Currently, there are four established scoring systems: Centofanti, GERAADA, IRAD, and UK Aortic scores. These models exhibit varying degrees of accuracy in predicting mortality, underscoring the need for periodic revalidation, especially when dealing with unique patient challenges. Future research endeavors should focus on refining these scores to address the specific complexities associated with diverse clinical scenarios. This refinement aims to provide a more comprehensive and reliable predictive tool, enhancing its utility in guiding surgical decisions for ATAAD patients[62].

FUTURE PROSPECT: ENDOVASCULAR REPAIR OF ATAAD

Given the heightened risk profiles of populations outlined in this article, there has been a dedicated effort to explore and innovate strategies for endovascular repair options in the context of ATAAD. Although the application of TEVAR for ATAAD is still in its early phases, including experimental studies conducted with animal models[63], existing research already suggests that TEVAR is not only feasible but also holds the potential for superior outcomes compared to medical management alone.

For patients to be eligible for endovascular treatment, anatomic feasibility is paramount. Factors such as the location of the entry tear, ascending aortic diameter, involvement of critical structures like the aortic root or coronary arteries, and identification of an appropriate landing zone are crucial considerations[64].

A systematic review of 20 studies comprising 311 patients undergoing TEVAR for acute, subacute, or chronic type A aortic dissection demonstrates the procedure's feasibility in highly selective cases. The incidence of technical failure, stroke, and endoleaks was notably low at 0.22%, 0.1%, and 8.52%, respectively. While the 30-day postoperative complication rate stood at 7.08%, late complications occurred in 16.89% of patients. Encouragingly, one-, three-, and five-year survival rates were estimated at 87.15%, 82.52%, and 82.31%, respectively[65]. The study suggests that TEVAR is a viable option for carefully selected patients who are not suitable for open surgery, but further research is needed to address technical challenges and establish its long-term efficacy.

CONCLUSION

The management of ATAAD demands a nuanced and individualized approach tailored to the risk profile of each patient. Although early surgical repair remains the mainstay of management for appropriate operative candidates, the high risk of morbidity must be considered before proceeding to the operating room, particularly for frail patients, the elderly, those who have undergone previous cardiac surgery, and those with active organ malperfusion. In the highest-risk patients, medical management coupled with frank goals of care discussion may be preferable to avert surgery that is unlikely to be successful or to preserve an acceptable quality of life. Encouragingly, burgeoning endovascular techniques may offer lower-risk alternatives to traditional open approaches, potentially expanding the population of patients able to undergo effective early intervention. As the acute management options for ATAAD expand, perioperative risk scoring systems will increasingly aid patient-centered surgical decision making, though ongoing refinement is necessary to include new patient stratification concepts such as frailty. In summary, this comprehensive review aims to provide a stepwise approach to patient-centered decision-making in ATAAD management, recognizing the multifaceted challenges and evolving strategies in this critical field of cardiovascular surgery.

DECLARATIONS

Authors' contributions

Conducted literature search, screened articles for inclusion, and organized the overall structure of the review: Faggion Vinholo T

Contributed to the critical analysis of selected studies, and synthesized key findings: Faggion Vinholo T, Awtry J, Semco R, Newell P, Sabe AA

Reviewed and revised the manuscript for clarity, coherence, and consistency, and provided valuable feedback on the overall narrative and argumentation: Sabe AA

Availability of data and materials

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Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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