Iatrogenic Type A Aortic Dissection: A Narrative Review Of Endovascular And Surgical Management Strategies And Outcomes

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Abstract:

Iatrogenic Type A aortic dissection (iTAAD) is a fatal but infrequent complication of or following cardiac and endovascular interventions. With advancing interventional and surgical cardiovascular technology, paradoxically, iTAAD incidence has risen, prompting a reassessment of current diagnostic, therapeutic, and prevention concepts. This narrative Review strives to integrate recent evidence of surgical and endovascular repair of iTAAD, summarize trends in outcomes, and enumerate the most important innovations that have impacted clinical practice. Indexed journals and contemporary clinical evidence (2021-2025) were systematically searched. Six extremely relevant studies, including case reports, systematic reviews, and observational analysis, were selected for inclusion and analysis based on direct relevance to iTAAD pathophysiology, surgical treatment, and perioperative outcomes. Evidence suggests that while iTAAD remains treated mainly by open surgical repair, complete endovascular solutions are increasingly viable options in meticulously selected high-risk or delay-presenting patients. Success at operation is strongly associated with early detection, dissection anatomical extent, and institutional expertise. Comparative outcomes suggest increased mortality in iTAAD vis-a-vis spontaneous dissection but with the introduction of newer hybrid and branched stent technology. iTAAD management necessitates an update in a multidisciplinary approach based on early diagnosis and tailored treatment. While surgery remains the prevailing modality, endovascular innovation transforms the therapeutic landscape and challenges prevailing dogma. Prospective registries are required to validate optimal algorithms and improve patient survival.

Keywords: Aortic injury, Cardiovascular interventions, Endovascular therapy, Postoperative complications, Risk stratification, Surgical trends

Introduction & Background

Learning Aortic Dissection and Clinical Significance

Acute aortic dissection is among the most catastrophic cardiovascular emergencies, consisting of an intimal tear of the aorta to permit blood to enter the medial layer to create a false lumen. Stanford Type A aortic dissections of the ascending aorta are particularly lethal, with mortality increasing by 1–2% per hour without treatment [1]. These dissections have traditionally preceded spontaneous onset secondary to medial degeneration due to hypertension, connective tissue disease, or atherosclerosis. However, there is a less frequent but increasingly recognized subgroup, which is iatrogenic [2].

Defining Iatrogenic Type A Aortic Dissection (iTAAD)

Iatrogenic Type A aortic dissection (iTAAD) is a dissection of the ascending aorta resulting from direct medical or surgical intervention. Although rare, estimated to occur in 0.06–0.23% of cardiac surgery and less frequently following catheter-based procedures, it is associated with a stunningly high mortality [3]. The disease can occur intraoperatively, minutes after the procedure, or days postprocedure, typically secondary to mechanical injury from cannulation, clamping, balloon inflation, guidewire manipulation, or stent deployment. iTAAD thwarts existing therapeutic paradigms with its abrupt onset, multiplanar anatomical problems, and high-risk patient subset [4].

Incidence and Procedural Triggers

The growing use of minimally invasive and catheter-based interventions has unintentionally increased the incidence of iTAAD. All these interventions, such as percutaneous coronary interventions (PCI), transcatheter aortic valve replacements (TAVR), and thoracic endovascular aortic repairs (TEVAR), have been associated with retrograde Type A dissections [5]. Though unusual, these result from mechanical stress on the aortic wall, more so in the presence of concomitant aortic dilation or stiff connective tissue. Intraoperative interventions such as aortic cannulation for cardiopulmonary bypass, aortic cross-clamping, or venting also cause dissection when technical precision is lost [6].

Clinical Presentation and Diagnostic Challenges

iTAAD patients may present with acute hemodynamic collapse, chest pain, neurological presentation, or signs of visceral or limb malperfusion. In sedated or postoperative patients, symptoms are masked or muted, leading to a delay in diagnosis. Imaging must be emergent, typically with contrast-enhanced CT angiography to characterize the dissection flap, identify true vs false lumen, and guide surgery. Delayed diagnosis severely aggravates prognosis; thus, the high degree of suspicion must be preserved following high-risk interventions [7].

Surgical Urgency and Therapeutic Evolution

Historically, emergent open surgical repair was the only effective treatment for iTAAD, including replacement of the ascending aorta, with or without hemiarch or total arch procedures. Effective as it is, this is fraught with catastrophic risks especially in comorbid or prior sternotomized patients [8]. Recent institutional reports and case series have noted endovascular stenting as a possible option in selected cases, namely in delayed or retrograde dissections in which anatomy is amenable to safe deployment. Such techniques involve branched and fenestrated grafts or hybrid techniques involving debranching and endograft delivery. Although not yet standardized, such innovations are altering management protocols and expanding the armamentarium available for high-risk cases [9].

Rationale for a Narrative Review

Due to the rarity of iTAAD and the heterogeneity of its etiology, presentations, and treatment, clinical guidelines are not specific, and no randomized clinical trials are available. An overdue and critical systematic narrative review is thus provided here to integrate current evidence, compare results between endovascular and surgical treatments, and delineate evidence gaps. Integrating current high-quality literature and case-based evidence, the Review tries to supply clinicians with a systematic overview of iTAAD pathogenesis, technical considerations in management, and novel trends that may shape future treatment strategies.

The reason behind the Review

iTAAD is an uncommon, life-threatening condition with diverse etiology and restricted standardized treatment protocols. The absence of randomized trials and dissimilar clinical data creates a central practice evidence gap. This Review aims to integrate new evidence, establish new treatment paradigms, and facilitate evidence-based clinical decisions in this complex surgical scenario.

Scope of the Review

This Review discusses the mechanism and procedural triggers of iatrogenic Type A aortic dissection, with special reference to diagnostic methods and imaging modalities for early detection. It compares open surgical repair with newer endovascular methods, discusses postoperative complications and results, and presents recent information from clinical studies published in 2021-2025.

Purpose of the Review

To discuss and critique recent surgical and endovascular methods of treatment of iatrogenic Type A aortic dissection widely, highlighting clinical results, new technologies, and practical issues.

Review of Literature

Current literature emphasizes the growing appreciation and sophistication of iatrogenic Type A aortic dissection (iTAAD). Biancari et al. (2025) compared Type A dissection surgical results and emphasized the impact of the extent of repair on long-term survival, especially in emergencies [10]. Bauer et al. (2025) alluded to iatrogenic dissections occurring in the process of minimally invasive valve surgery and alluded to surgical technique and intraoperative awareness as pivotal to prevention [11]. Manan et al. (2024) reported a case of iTAAD after percutaneous coronary intervention and emphasized the danger of catheter-based manipulation of the vulnerable aortic segments [12].

Carrel et al. (2023) presented a detailed account of acute aortic dissection, establishing risk factors and emphasizing surgical repair [13]. Pitts et al. (2021) presented newer surgical techniques, contrasting conventional open repairs with hybrid and minimally invasive techniques in acute Type A dissections [14]. Likewise, Ali-Hasan-Al-Saegh et al. (2023) performed a meta-analysis of retrograde Type A dissections after TEVAR for Type B dissections, comparing it with device-induced iatrogenic injury [15] as evident from Table/Fig 1.

Table/Fig 1: Literature Review – Previous Work [10-15].

Authors (Year)	Key Finding	Research Focus	Challenges/Limitations	Future Scope
Biancari et al. (2025) [10].	The extent of aortic repair influences outcomes in Type A dissection surgery.	Surgical extent vs. outcomes in Type A dissection	Lack of consensus on the optimal surgical extent	Define optimal surgical extent by patient profile
Bauer et al. (2025) [11].	iTAAD can occur during minimally invasive valve surgeries due to technical risks	Intraoperative causes of iTAAD in valve surgeries	Small sample size; limited generalizability	Develop preventive protocols during valve surgery
Manan et al. (2024) [12].	PCI procedures can cause iTAAD, requiring emergency surgical intervention	Case report of iTAAD after PCI	Single case report; lacks broader applicability	Aggregate similar case data for trend analysis
Carrel et al. (2023) [13].	Acute aortic dissection needs rapid diagnosis and immediate surgical treatment.	Comprehensive overview of acute aortic dissection	Not focused solely on iatrogenic cases	Differentiate spontaneous vs. iatrogenic dissection in studies
Pitts et al. (2021) [14].	Open and hybrid surgical techniques offer varied outcomes for Type A dissection.	Techniques in surgical treatment of acute Type A dissection	Lack of patient-level outcome standardization	Compare hybrid vs. traditional repair outcomes

Ali-Hasan-Al-Saegh et al. (2023) [15].	TEVAR for Type B dissection may lead to retrograde iTAAD in some patients	Meta-analysis of retrograde iTAAD after TEVAR	Limited data on long-term endovascular outcomes	Explore safer device designs to prevent retrograde dissection

Legend: Summarization of past work reviewing surgical outcomes, problems, and evolving strategies for iatrogenic aortic dissection.

Materials and Methods

Locating Data:

An in-depth search was conducted from PubMed, Scopus, and ScienceDirect for peer-reviewed articles on iatrogenic Type A aortic dissection (iTAAD). Search words like iatrogenic aortic dissection, endovascular repair, ascending aorta surgery, and retrograde dissection were combined. Those publications between January 2021 and May 2025 were deemed current and pertinent.

Data Collection:

Titles and abstracts were filtered, and full texts were read to include them. Expert consensus statements, systematic reviews, case reports, and observational studies discussing the etiology, diagnosis, and management of iTAAD were eligible sources to be included. High-impact cardiovascular and surgical journals were prioritized.

Data Extraction

Key information points such as study design, patient population, mechanism of dissection, intervention type (surgical vs. endovascular), complications, and clinical results were extracted and tabulated in organized templates. Duplicates and studies with indeterminate procedures or outcomes were not included.

Synthesizing Data:

Extracted data were qualitatively synthesized. Comparative themes were drawn between studies to identify changing trends, clinical issues, and areas needing standardized care. Results were categorized by procedure context and therapeutic strategy to Project an integrated picture of the contemporary management scenario of iTAAD.

Result

Procedural Triggers and Mechanisms of Iatrogenic Type A Aortic Dissection

Iatrogenic Type A aortic dissection (iTAAD) is a lethal complication of mechanical trauma to the intimal layer of the ascending aorta during cardiovascular surgery. The most common intraoperative causes are aortic cannulation for cardiopulmonary bypass, aortic cross-clamping, and aortic venting [16]. Excessive force, positioning the cannula tips in the wrong place, or the cannulation of a diseased or dilated aortic segment can be responsible for intimal disruption and false lumen creation. Clamping over calcified or hard walls of the aorta can propagate a dissection flap. Intraoperative injuries can be occult intraoperatively but have an increased rate of progression in the early postoperative period, eventually leading to hemodynamic instability or cardiac tamponade [17].

During catheter-based interventions, like percutaneous coronary intervention (PCI), transcatheter aortic valve replacement (TAVR), and thoracic endovascular aortic repair (TEVAR), trauma may occur due to guidewire manipulation, balloon inflation, or device deployment. Retrograde dissections extending to the ascending aorta have been particularly reported following TEVAR for type B dissections caused by high-pressure jet streams and stent-induced wall trauma [18]. The risk is also increased in patients with a history of aortic dilation, cystic medial necrosis, or connective tissue diseases, where the aortic wall is already compromised. Oversizing of the device, excessive torque, or repositioning during deployment may increase mechanical stress, leading to a tear [19]. With increasing endovascular intervention, heightened awareness and procedural vigilance are required to avoid iatrogenic injury and to facilitate safe passage through the ascending aorta, as in Table/Fig 2.

Table/Fig 2: Iatrogenic Type A Aortic Dissection – Procedural Triggers and Mechanisms [16-19].

Author (First) et al.	Surgical Causes of iTAAD	Catheter-Based Intervention Risks	Mechanisms of Aortic Injury	High-Risk Patient Factors	Prevention Strategies
Klaudel et al. [16].	Not the primary focus; mentions propagation post-surgical manipulation	Extensive; describes wire, catheter, and balloon-induced dissections	Describes shear stress, intimal tears, and propagation along weakened aorta	Notes hypertension, advanced age, and atherosclerosis	Advocates for gentle manipulation and imaging-guided procedures
Al-Gburi et al. [17].	Briefly notes surgical cannulation and clamping as potential triggers	Summarizes PCI and TAVR-related dissection risks	Outlines mechanical trauma and pressure-induced wall rupture	Mentions of connective tissue disorders and vessel fragility	Recommends procedural planning and early suspicion protocols
Safdar et al. [18].	Highlights injury during aortic root instrumentation in CTO procedures	Detailed focus on dissection during complex percutaneous coronary interventions	Emphasizes guidewire-related entry tear and balloon over-expansion	Highlights calcified vessels and chronic total occlusion	Suggests minimizing contrast load and stepwise dilations
Murillo et al. [19].	Acknowledges surgical trauma as one trigger in acute syndromes	Explains catheter-induced dissection as part of broader aortic syndromes	Illustrates imaging evidence of flap progression and wall dissection	Includes inherited disorders and chronic hypertension	Encourages vigilant imaging followup and early diagnosis

Legend: This table summarizes prominent procedural and anatomical contributors to iTAAD from four seminal studies.

Diagnostic Approaches and Imaging Modalities in iTAAD Diagnosis [20-23].

Early and correct diagnosis of iatrogenic Type A aortic dissection (iTAAD) is paramount, as clinical deterioration may be rapid and lethal. Awake iTAAD may manifest with acute chest pain, hypotension, or neurological deficit, but in sedated or postoperative settings, these may be masked, and diagnosis may be difficult [20]. High suspicion is required for early detection, particularly after high-risk interventions such as cardiopulmonary bypass, PCI, or TEVAR. Hemodynamic instability, elevated lactate, pericardial effusion, or unexplained ventricular dysfunction should raise a suspicion of aortic trauma and prompt investigation [21].

Computed tomography angiography (CTA) is the gold standard for iTAAD diagnosis, providing high-resolution imaging of aortic lumen, dissection flap, and branch vessel compromise. CTA is best suited for evaluating the extent of dissection and preoperative planning for surgery or endovascular repair. Transesophageal echocardiography (TEE) is a valuable intraoperative imaging modality for real-time imaging of the ascending aorta and detection of intimal tears or false lumen formation before chest closure [22]. TEE is also critical for valve repair or replacement and cannulation to enable accurate instrument placement and identification of dissection as it happens. TEE can hint at iTAAD when CTA is unavailable in real-time in emergencies. These modalities are part of a complementary diagnostic approach, enabling early detection, procedural planning, and postoperative followup in at-risk or suspected iTAAD patients [23], as shown in Table/Fig 3.

Table/Fig 3 Diagnostic Approaches and Imaging Modalities for Iatrogenic Type A Aortic Dissection (iTAAD) [20-23].

Author et al.	**Clinical Presentation and Challenges**	**Imaging Modalities for Diagnosis**	**Role of CTA**	**Intraoperative TEE**	**Complementary Diagnostic Framework**
Acharya et al. [20]	Describes sudden chest pain and hemodynamic instability; diagnosis delayed by symptom overlap with ACS.	Recommends CTA, TEE, and MRI as diagnostic cornerstones	Highlights CTA as first-line imaging for diagnosing Type A dissection	Supports TEE as a real-time intraoperative and ICU monitoring tool	Stresses multimodal imaging integration for accurate diagnosis and risk assessment
Cox et al. [21].	It focuses on systemic signs linked to inflammation but is less specific to and presentation.	Briefly addresses CT and MRI for aortic pathology; not centered on iTAAD	Mentions CT utility in detecting aortic wall changes	Not discussed in depth; TEE not emphasized	Notes inflammatory markers as an adjunct to imaging
Gudbjartsson et al. [22].	Highlights classic symptoms and diagnostic urgency in acute settings	Supports TEE and CTA as rapid, primary diagnostic tools	Reinforces CTA as the gold standard for dissection visualization	Recommends TEE for intraoperative diagnosis and monitoring	Proposes the use of clinical scoring and rapid imaging access
Ciccone et al. [23].	Emphasizes nonspecific symptoms; outlines diagnostic confusion in early dissection stages.	Systematic comparison of CTA, TEE, MRI, and chest X-ray	Explores CTA's high sensitivity, real-time 3D reconstruction	Presents TEE as vital for bedside and intraoperative use	Advocates layered diagnostic pathway using combined modalities

Legend: The above table depicts how extensive studies encompass imaging-based diagnostic methods for iTAAD, including CTA, TEE, and combined models.

Open Surgical Repair: Indications, Techniques, and Clinical Outcomes

Open surgical repair remains the gold standard for managing iatrogenic Type A aortic dissection (iTAAD), particularly in hemodynamic instability, pericardial tamponade, or aortic root involvement. The key surgical undertakings are the extirpation of the entry tear, aortic continuity restoration, and prevention of rupture or malperfusion [24]. Hemiarch replacement is employed for dissection limited to the ascending aorta and proximal arch, with less operative time and risk of cerebral ischemia. Total arch replacement is employed if the dissection extends beyond the innominate artery or with aneurysmal disease or branch vessel damage. The decision is based on anatomical extent, timing of intervention, and patient stability [25].

Outcomes in iTAAD are highly variable and dependent on early diagnosis, institutional experience, and etiology. Intraoperative mortality with emergency intervention is higher compared to spontaneous dissection, mainly due to delayed diagnosis and comorbidities. However, studies have found that early repair by experienced aortic teams has acceptable outcomes [26]. Postoperative morbidity may be a stroke, renal failure, bleeding, or recurrent dissection, but improvement in cerebral perfusion and myocardial protection has enhanced survival [27]. Despite these advances, the absence of a standardized protocol and severe heterogeneity of patient populations necessitate individualized surgical strategies to optimize outcomes in Table/Fig 4.

Table/Fig 4 Open Surgical Repair for Iatrogenic Type A Aortic Dissection (iTAAD): Indications, Techniques, and Outcomes [24-27].

Author et al.	Indications for Open Surgical Repair	Surgical Techniques and Goals	Hemiarch vs. Total Arch Replacement	Clinical Outcomes and Complications	Individualized Surgical Strategies
Hong et al. [24].	Standard for hemodynamic instability, root involvement, or retrograde extension	Emphasizes rapid cannulation, hypothermic arrest, and root/hemiarch repair	Advocates hemiarch unless arch tear mandates total replacement	Low mortality with experience; neurological events and bleeding noted	Tailored to anatomy, timing, patient status
Eranki et al. [25].	Performed in all acute presentations; focus on survival improvement	Describes conventional sternotomy, graft replacement with cerebral protection	Hemiarch preferred to reduce the operative burden	Quality of life is generally favorable; survivors face chronic pain and anxiety.	Stresses patient-centered approach and surgical judgment
Hameed et al. [26].	Primary treatment when dissection threatens aortic rupture or malperfusion	Focus on proximal aortic repair and minimizing ischemia	Brief mention: approach individualized	Early intervention improves outcomes; mortality remains high if delayed	Supports anatomy-based decisions
Benedetto et al. [27].	National audit: repair indicated in nearly all Type A cases with significant complications	Highlights institutional variability; median sternotomy and ascending aorta grafting common.	Total arch is more common in high-volume centers; hemiarch is still predominant.	National data show 17% mortality; stroke and reintervention rates are significant.	Data support risk-based stratification for procedure type and extent

Legend: Brief table of open surgical methods for iTAAD, including indications, technique, and patient-specific strategy modulation from four reference articles.

New Endovascular Interventions: Feasibility, Case Uses, and Limitations

Endovascular repair of iatrogenic Type A aortic dissection (iTAAD) is increasingly popular as a rescue strategy in patients not candidates for open repair due to age, comorbidities, or previous sternotomies. While the ascending aorta contains inherent anatomic difficulties such as proximity to coronary ostia and dynamic motion, new technology has improved endovascular repair [28]. Custom stent grafts, branched stent grafts, and rapid-deployment systems have been selectively applied to seal the entry tear and restore proper lumen perfusion without cardiopulmonary bypass. In hybrid procedures, supra-aortic vessel debranching can be achieved by open technique followed by stent-graft placement, striking a balance between invasiveness and efficacy [29].

Small series and case reports have reported technical success with endovascular repair, particularly in delayed or retrograde dissections following TEVAR or TAVR. These approaches are typically reserved in hemodynamically stable patients with imaging confirmation of suitable landing zones. Limitations remain. Availability of devices, the lack of off-the-shelf devices, and the risk of endoleaks or incomplete coverage restrict more extensive use [30]. Furthermore, the pulsatility and curvature of the ascending aorta demand careful deployment, which is complicated with the current stent designs. Long-term outcomes are largely unreported, and procedural success is center-dependent. Despite this, ongoing trials and device development foretell an increasing role for endovascular repair in carefully selected cases of iTAAD as procedural refinement and imaging guidance improve [31].

Comparative Outcomes: Mortality, Complications, and Procedural Timing in iTAAD

The clinical picture of iatrogenic Type A aortic dissection (iTAAD) is highly variable in terms of management approach and the timing of diagnosis. Open repair, with its attendant high perioperative complication rate, is the strongest established therapy, particularly in the context of acute presentation with hemodynamic instability [32]. In-hospital mortality following surgical repair for iTAAD has ranged between 20% and 40%, usually secondary to patient comorbidities, a delay in diagnosis, and dissection severity. Stroke, bleeding, renal failure, and prolonged mechanical ventilation are the most common complications. Despite such complications, surgical repair has been shown to have long-term outcomes, especially in centers of excellence and by early intervention approaches [33].

Endovascular repair, being less invasive, is generally reserved for highly selected, anatomically favorable cases with delayed or retrograde patterns of dissection. Initial experience reports lowering perioperative morbidity and hastened recovery, but stent migration and risk of incomplete exclusion of the entry tear and long-term durability are concerns. Reintervention rates following endovascular therapy are uncertain and generally based on procedure and patient-related factors [34]. Presentation timing is a crucial determinant in both modalities; delayed presentation, particularly in non-tertiary referral centers, is associated with poorer outcomes due to irreversible end-organ damage. Comparative data for endovascular versus surgical repair are presently limited to case series and retrospective reports, with no randomized trial. Improvement in imaging, patient selection, and individualized therapeutic planning is increasingly improving survival rates and reducing complications in this high-risk patient population [35].

Evidence Gaps and Future iTAAD Management Research Directions

Despite greater awareness and case-based experience, the management of iatrogenic Type A aortic dissection (iTAAD) remains underreported in clinical literature. Most existing literature comprises retrospective case series, single-institution reports, or individual case presentations that preclude generalizability [36]. No standardized definition, reporting standard, or long-term followup data exist, precluding study-to-study direct comparison. Most large-scale studies of aortic dissection fail to also stratify by spontaneous and iatrogenic causes, obscuring iTAAD-specific presentation patterns, risk factors, and outcomes [37]. The absence of stratified data precludes the creation of predictive models and individualized management algorithms. Prospective multicenter registries dedicated solely to iTAAD will be needed to identify early warning signs of injury, procedural considerations, and treatment outcomes in varied clinical environments. Another immediate need is the performance of focused clinical trials to compare open and endovascular repair in anatomically suitable patients. Technological advancement must develop stent-grafts explicitly designed for the ascending aorta with greater flexibility, accurate deployment, and adaptability to accommodate varied aortic diameters [38]. Exploration of intraoperative imaging modalities and real-time diagnostic options may also enable earlier detection and avoidance of iatrogenic injury. Interdisciplinary cooperation between cardiac surgeons, interventional cardiologists, imaging professionals, and device makers will be necessary to push the field forward. Lastly, remodeling the current reactive treatment paradigm to a proactive and precision-based one will dramatically enhance patient outcomes and decrease iTAAD-related mortality [39].

Discussion

Iatrogenic Type A aortic dissection (iTAAD) is a comparatively rare but catastrophic complication, increasingly seen in today's cardiovascular practice with the increase in the use of surgical and catheter-based interventions. While its frequency is still low compared with spontaneous dissection, mortality and morbidity in iTAAD are disproportionate [40]. This is primarily because of its sudden presentation, diagnostic complexity, and the fragile anatomical site of the ascending aorta, which tolerates little procedural error. Thus, iTAAD requires increased procedural care, prompt identification, and appropriate intervention strategies that are quite different between surgical and endovascular specialties [41].

Surgical aortic manipulation, particularly with cannulation, cross-clamping, or proximal anastomosis, remains the most frequent etiology of iTAAD. Such mechanical injury is generally compounded in atherosclerotic, dilated, or connective tissue–injured aortas [42]. Similarly, catheter interventions such as PCI, TAVR, and TEVAR risk by wire passage, balloon dilatation, or device deployment, particularly in intimal damage or friability. Spontaneous dissections are preceded by long-standing medial degeneration. At the same time, iTAAD is characterized by acute mechanical disruption in a localized area of vascular tissue, and therefore its clinical course is acute and unpredictable [43].

Diagnosis of iTAAD is difficult, especially in the perioperative or postoperative period when patients are sedated, intubated, or have nonspecific signs of deterioration. Imaging is then the most critical. CT angiography is still the gold standard diagnostic imaging because it can clearly visualize dissection flaps, entry points, and branch involvement [44]. Intraoperative transesophageal echocardiography (TEE) is, however, optimal for real-time detection, especially during the high-risk maneuvers of cannulation and decannulation. Using these modalities simultaneously ensures early detection, which is important because delayed diagnosis is directly proportional to mortality [45].

Surgical repair has been the standard management of iTAAD and continues to be the modality of choice in most institutions. The extent of surgical intervention depends on the site of the entry tear, patient stability, and institutional preference. Hemiarch replacement is a common strategy in localized dissections, with total arch procedures reserved for dissections to the distal or major branches [46]. While generally satisfactory in high-volume institutions, surgical outcomes are still laden with high risk. Postoperative complications like neurological injury, hemorrhage, and multi-organ failure are not uncommon, especially with emergent presentations or patients with a delayed onset of symptoms. However, surgery allows for definitive management through resectioning the dissection flap and aortic anatomy restoration, except for rupture and malperfusion [47].

The decade has seen increasing interest in endovascular approaches as a less invasive option than open surgery. Though the curvature, motion, and proximity of the ascending aorta to critical structures present intimidating challenges, there have been encouraging results in selected patients from several case reports and small series. Endovascular stent-grafts, especially customized or branched stent-grafts, have been employed in managing retrograde dissections or delayed iTAAD in stable patients [48]. Hybrid approaches consisting of surgical debranching head vessels followed by stent implantation have also been described, providing an intermediate solution for high-risk surgical candidates but not candidates for complete endovascular repair. However, this is still limited by the availability of devices, anatomical limitations, and the absence of long-term durability data. The current consensus is, therefore, in favor of endovascular treatment only in high-technology centers with favorable anatomy [49].

Comparison of endovascular and surgical outcomes remains challenging because of heterogeneity in the repair timing, patient selection, and study design. Surgical repair is typically associated with elevated initial mortality from the acuity of presentation and complexity of repair but with generally more robust long-term outcomes [50]. The endovascular repair can offer short-term benefits in recovery and invasiveness of the procedure but is also associated with risks of incomplete coverage of the tear, endoleak, or reintervention. Mortality rates for iTAAD are typically higher than for spontaneous dissections, which represents the unique clinical conundrum that it is. Complication rates, particularly stroke and renal impairment, are high and are typically confounded by procedural delay or attendant comorbidities [51].

One of the most important issues emerging from the literature is the underrepresentation of iTAAD in large-scale dissection databases and clinical trials. Most studies aim at spontaneous dissections; iatrogenic ones are excluded or not reported separately. This precludes the derivation of iTAAD-specific data on risk stratification, optimal treatment algorithms, or prognostic indicators [52]. In addition, owing to its rarity, most of the data are retrospective reviews or single-center experiences, precluding generalizability. These gaps in evidence produce uncertainty in clinical decision-making, especially in determining the feasibility of newer, minimally invasive techniques [53].

In the future, there is an urgent need for prospective multicenter registries of iTAAD. These would allow standardized reporting of mechanisms, imaging, intraoperative factors, and postoperative outcomes to provide a stronger evidence base. Importantly, innovation in device design is also needed. Existing stent-grafts are not necessarily optimal for the usual geometry and hemodynamics of the ascending aorta [54]. The design of purpose-built ascending aortic devices that are flexible, adaptive, and compatible with the high-pressure environment is needed to allow safe and effective endovascular repair. Artificial intelligence in imaging may also enable earlier detection and risk prediction on procedures. Also, simulation-based training and real-time navigation technologies may decrease operator-dependent iatrogenic risk [55].

Conclusion

Iatrogenic Type A aortic dissection (iTAAD) is an emergent and uncommon complication of cardiovascular surgery, necessitating early diagnosis and careful treatment. Open repair is still the gold standard of therapy, particularly in hemodynamically unstable patients, but emerging endovascular techniques have the potential for judiciously selected anatomy and patient profiles. Diagnostic experience with CTA and intraoperative TEE imaging modalities is essential in early management. Individualized clinical decision-making is the standard in the dearth of large-scale stratified data. Innovation in the future will have to meet the challenge of the design of purpose-specific endovascular devices, multicenter registry extensions, and standardized protocols to improve outcomes. Multidisciplinary coordination and cooperation between surgeons, interventionalists, and imaging experts will be paramount in optimizing treatment pathways and expanding therapeutic opportunities in this high-risk population of patients.

Key Takeaways

iTAAD is a highly lethal condition requiring urgent diagnosis and tailored treatment. Surgical repair remains the standard, and endovascular therapy is in progress. Imaging is central to early detection and procedural safety. Despite promising innovations, management is hindered by a lack of information and consensus on guidelines. Outcomes will depend on dedicated research, specialist device innovation, and coordinated, multidisciplinary care pathways within cardiac and vascular specialties. Proactive, evidence-based, and patient-tailored approaches will be required to reduce mortality and procedural risk.

Ethical Consideration

This article reviews previously published literature and does not involve original research involving human participants or animals. Ethical approval was thus not required. Sources have been correctly cited according to academic convention.

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