AN OVERVIEW OF SURGICAL TREATMENT FOR ACUTE TYPE A AORTIC DISSECTION

Dr Manas Godbole,
Resident, Dept of Cardiology,
Krishna Institute of Medical Sciences, Karad, Maharashtra, India

Dr Pravin Salunkhe,
Assistant Professor Department of Carrdiothoracic dept,
Krishna Institute of Medical Sciences, Karad, Maharashtra, India

Dr Vijay Patil, Assistant Professor
Department of Cardiology,
Krishna Institute of Medical Sciences, Karad, Maharashtra, India

Abstract

Acute type A aortic dissection (ATAAD) is a life-threatening condition that requires urgent surgical intervention. The standard treatment for ATAAD is open surgical repair, which involves replacement of the ascending aorta and the aortic valve. This review article provides a comprehensive overview of the surgical techniques, outcomes, postoperative management, complications, and future directions for the surgical treatment of ATAAD. The article highlights the importance of prompt diagnosis and intervention, the potential complications associated with surgical treatment, and the need for continued research and innovation to improve outcomes for patients with this challenging condition.

KEY WORDS: Acute type A aortic dissection, Surgical Treatment, cardiovascular, non-cardiovascular conditions, transesophageal echocardiography, computed tomography angiography

Introduction

"*Acute type A aortic dissection* (ATAAD)" is a life-threatening condition that requires urgent surgical intervention to prevent mortality and morbidity (1). Despite improvements in diagnostic imaging and surgical techniques, the mortality rate for untreated ATAAD remains

high, with up to 50% of patients dying within 48 hours of onset (2). Therefore, prompt and appropriate surgical management is crucial for improving patient outcomes.

Surgical treatment for ATAAD has evolved significantly over the past few decades, with various approaches and techniques developed to improve outcomes and reduce morbidity (3). However, the optimal surgical strategy for ATAAD remains a topic of debate and ongoing research (4). This review aims to provide an overview of the current surgical treatment options for ATAAD and the evidence supporting their use.

Epidemiology and Etiology of ATAAD

The incidence of ATAAD is estimated to be 2.9-3.5 cases per 100,000 person-years, with a male predominance (5). The etiology of ATAAD is complex and multifactorial, with a combination of genetic, environmental, and lifestyle factors contributing to the development of the disease (6).

The likelihood of having ATAAD has been linked to a number of hereditary diseases, including Loeys-Dietz syndrome, Ehlers-Danlos syndrome, and Marfan syndrome (7). Environmental factors that are significant risk factors for ATAAD include hypertension, smoking, and cocaine use (8).

The incidence of ATAAD has been reported to increase with age, with the majority of cases occurring in individuals over the age of 50 years (9). In addition, there is a higher incidence of ATAAD in individuals with a history of cardiovascular disease, such as aortic aneurysms or aortic valve disease (10).

Understanding the epidemiology and etiology of ATAAD is critical for the development of effective prevention and management strategies for this condition. In this review, we provide a comprehensive overview of the surgical treatment of ATAAD, with a focus on the latest advances and techniques used in the management of this complex disease.

Clinical Presentation of ATAAD

A variety of symptoms can be present in ATAAD, a disorder that poses a serious risk to life. The most typical sign is an abrupt, intense chest discomfort that may extend to the back or abdomen (11). Syncope, shortness of breath, neurological impairments, and hypotension are examples of other symptoms (12). The clinical presentation can be highly variable depending

on the location and extent of the dissection, as well as any associated complications (2). In some cases, patients may be asymptomatic, and the dissection may be incidentally discovered on imaging studies performed for other reasons (13). The predominant initial manifestation is an abrupt and intense thoracic discomfort frequently characterized as a tearing or ripping sensation. Additional prevalent indications comprise of lumbar discomfort, stomach discomfort, fainting, breathing difficulties, and impairments in the nervous system. It is noteworthy that the manifestation of classic symptoms is not universal among patients with ATAAD, and in certain instances, the clinical presentation may be subtle or atypical. The diagnosis of ATAAD can be challenging, as the presenting symptoms are often nonspecific and can mimic other cardiovascular and non-cardiovascular conditions. A high degree of suspicion is needed, and clinicians should consider the possibility of ATAAD in any patient with acute chest pain or other suggestive symptoms (6). It is recommended that a comprehensive clinical assessment be conducted, encompassing an elaborate medical history and physical examination, electrocardiography, and imaging modalities such as "Computed Tomography Angiography (CTA)" or "Magnetic Resonance Imaging (MRI)" (5). Early diagnosis and prompt management are critical in ATAAD, as delayed treatment can result in significant morbidity and mortality (14). Therefore, any patient suspected of having ATAAD should be promptly referred to a specialized center capable of providing emergent surgical intervention (13).

Patients with proximal dissections involving the ascending aorta are at higher risk of complications such as cardiac tamponade, aortic regurgitation, and aortic rupture, and may present with more severe symptoms. In contrast, patients with distal dissections involving the descending aorta may present with more subtle symptoms, such as hypertension, lower extremity ischemia, or stroke.

The physical examination may present certain observations such as a variation in blood pressure between the bilateral arms, a murmur indicating aortic regurgitation, deficits in pulse, or neurological deficits (13). Nonetheless, it should be noted that the lack of aforementioned discoveries does not preclude the possibility of ATAAD diagnosis. As such, imaging examinations are imperative in verifying the diagnosis and directing the course of treatment (6).

It is imperative to maintain a heightened level of suspicion in order to promptly diagnose and treat ATAAD, especially in individuals with risk factors such as a history of hypertension, connective tissue disorders, bicuspid aortic valve, or previous aortic surgery (5). Furthermore, it should be noted that a familial background of aortic dissection or abrupt cardiac demise may augment the likelihood of developing this ailment (14).

Diagnosis and Preoperative Assessment

Diagnosis and preoperative assessment of ATAAD are critical steps in guiding the management and surgical treatment of the condition (15). Clinical suspicion of ATAAD should prompt immediate diagnostic imaging, such as CTA or "*Transesophageal Echocardiography* (TEE)", which have high sensitivity and specificity for diagnosing the condition (2,12). Other imaging modalities such as MRI and *Aortography* may also be useful in certain cases (7).

Apart from imaging, a thorough preoperative assessment is imperative to determine the most suitable surgical approach, taking into account the patient's comorbidities, risk factors, and clinical status (16). This assessment may involve laboratory testing, "*Electrocardiography* (ECG)", and cardiac biomarker measurement to evaluate cardiac function and identify any associated myocardial damage or complications (17).

Proper diagnosis and preoperative assessment are crucial to guide the surgical management of ATAAD, and a multidisciplinary approach involving cardiac surgeons, interventional cardiologists, and imaging specialists is often necessary to optimize patient outcomes (18).

Surgical Options for ATAAD

The customary approach for managing ATAAD is surgical intervention, with the selection of a specific surgical technique contingent upon the location and scope of the dissection. The predominant surgical technique involves the substitution of the impacted portion of the aorta with an artificial conduit, as reported in reference 19. The most appropriate surgical approach may differ based on the patient's clinical condition, presence of other medical conditions, and anatomical factors.

The Bentall procedure is a frequently employed surgical technique that entails the substitution of the aortic root and ascending aorta with a composite graft (20). This particular

method is frequently favored for individuals who exhibit aortic valve impairment or notable expansion of the aortic root. The David procedure is a surgical alternative that entails a valve-sparing aortic root replacement. This procedure is recommended for patients with a normal aortic valve or mild aortic regurgitation, as per reference (21).

Apart from the conventional surgical procedures, certain cases may require the utilization of minimally invasive methods like endovascular stent grafting (22). The proposed methodology entails the insertion of a stent graft within the aorta to reinforce the debilitated wall and redirect the blood flow from the location of the dissection.

The choice of surgical technique should be made based on careful consideration of the patient's clinical status, extent of the dissection, and anatomical factors. A multidisciplinary approach involving cardiac surgeons, interventional cardiologists, and imaging specialists is often necessary to determine the optimal surgical approach and ensure the best possible outcome for the patient (23).

Surgical Techniques and Strategies

ATAAD is a medical emergency that requires prompt diagnosis and treatment to prevent complications and improve patient outcomes. Surgical intervention remains the gold standard for the management of ATAAD. In this review, we will discuss various surgical techniques and strategies that can be employed in the management of ATAAD.

One of the most common surgical techniques used in the management of ATAAD is the Bentall procedure, which involves the replacement of the ascending aorta, aortic valve, and coronary arteries. According to a study by Harky et al., the Bentall procedure is associated with good short- and long-term outcomes in the management of ATAAD (24).

Another surgical technique that can be used in the management of ATAAD is the hemiarch replacement, which involves replacement of the ascending aorta and hemiarch. According to a retrospective study by Kouchoukos et al., hemiarch replacement is associated with low mortality and excellent long-term outcomes in the management of ATAAD (25).

In addition to these surgical techniques, there are various strategies that can be employed to optimize patient outcomes in the management of ATAAD. One such strategy is the use of hypothermic circulatory arrest, which involves cooling the body to reduce metabolic demand

during aortic surgery. According to a systematic review by Gutsche et al., hypothermic circulatory arrest is associated with improved neurological outcomes and reduced mortality in the management of ATAAD (26).

The surgical intervention remains the gold standard for the management of ATAAD. The Bentall procedure and hemiarch replacement are two common surgical techniques that can be employed, while strategies such as hypothermic circulatory arrest can be used to optimize patient outcomes.

Another surgical technique is the total arch replacement, which involves replacement of the entire aortic arch. According to a study by Matsuda et al., total arch replacement can be a safe and effective option for patients with ATAAD involving the aortic arch (27).

Endovascular stent grafting is a minimally invasive alternative to open surgical repair for ATAAD. According to a meta-analysis by Ji et al., endovascular stent grafting is associated with lower perioperative mortality and shorter hospital stays compared to open surgical repair (28).

Finally, medical management can be used for patients who are not candidates for surgical intervention or who decline surgery. Medical management typically involves controlling blood pressure and heart rate, as well as pain management and close monitoring of the patient's condition.

There are several interventions that can be used in the management of ATAAD, including surgical techniques such as total arch replacement and endovascular stent grafting, as well as medical management for patients who are not candidates for surgery.

Outcomes of Surgical Treatment

One of the most important outcomes of surgical treatment for ATAAD is mortality. According to a meta-analysis by Dong et al., the in-hospital mortality rate for surgical treatment of ATAAD is approximately 13% (29). However, the mortality rate varies depending on factors such as patient age, comorbidities, and surgical technique.

Another important outcome of surgical treatment for ATAAD is morbidity. Postoperative complications can include stroke, renal failure, and bleeding, among others. According to a study by Trimarchi et al., the incidence of postoperative complications after surgical

treatment for ATAAD ranges from 15% to 50% (30). The type of surgical technique used can also impact the incidence of postoperative complications.

Long-term outcomes are also important to consider in the evaluation of surgical treatment for ATAAD. According to a study by Park et al., the 10-year survival rate for patients who underwent surgical treatment for ATAAD was 60.7% (31). Factors that can impact long-term outcomes include patient age, comorbidities, and the type of surgical technique used.

The surgical intervention remains the gold standard for the management of ATAAD. Important outcomes to consider in the evaluation of surgical treatment include mortality, morbidity, and long-term survival. Factors that can impact these outcomes include patient characteristics and the type of surgical technique used.

Postoperative Management and Follow-up

Postoperative management and follow-up are crucial components of the overall management of ATAAD. In this review, we will discuss the postoperative management and follow-up for patients who have undergone surgical treatment for ATAAD.

After surgical treatment for ATAAD, close monitoring of the patient is necessary to detect and manage postoperative complications. According to a study by Kariyanna et al., postoperative monitoring should include frequent vital sign assessments, monitoring of fluid balance, and evaluation of organ function (32). Additionally, imaging studies such as echocardiography and computed tomography may be used to assess the effectiveness of the surgical intervention and detect any complications.

Blood pressure control is an important aspect of postoperative management for patients who have undergone surgical treatment for ATAAD. According to a study by Nishida et al., strict blood pressure control is necessary to prevent further aortic injury and reduce the risk of postoperative complications (33). Antihypertensive medications may be used to achieve blood pressure control, and close monitoring of blood pressure is necessary to adjust medications as needed.

Long-term follow-up is necessary to monitor for late complications and assess the effectiveness of the surgical intervention. According to a study by Roselli et al., long-term follow-up should include regular imaging studies and evaluation of aortic function (34).

Patients with residual dissection or aortic dilation may require additional intervention to prevent further complications.

The postoperative management and follow-up are important components of the overall management of ATAAD. Close monitoring for postoperative complications, blood pressure control, and long-term follow-up are necessary to ensure optimal outcomes for patients who have undergone surgical treatment.

Complications and Management Strategies

Surgical treatment for ATAAD is a complex procedure that carries the risk of various complications. In this review, we will discuss the complications associated with surgical treatment for ATAAD and the management strategies to address them.

One of the most common complications of surgical treatment for ATAAD is bleeding. According to a study by Svensson et al., the incidence of bleeding after surgical treatment ranges from 5% to 10% (35). Management strategies for bleeding include prompt diagnosis and intervention, administration of blood products, and surgical re-exploration if necessary.

Neurological complications are also a significant concern in patients undergoing surgical treatment for ATAAD. According to a study by Rylski et al., the incidence of stroke after surgical treatment ranges from 3% to 10% (36). Management strategies for stroke include prompt diagnosis and treatment with anticoagulants or antiplatelet agents, as well as management of underlying risk factors such as hypertension and hyperlipidemia.

Other potential complications of surgical treatment for ATAAD include renal failure, respiratory failure, and infection. Management strategies for these complications may include optimization of hemodynamics and electrolyte balance, early initiation of renal replacement therapy if necessary, and administration of antibiotics to treat infection.

In addition to these specific complications, it is important to monitor patients for signs of postoperative complications such as wound infection, sepsis, and bleeding. Management strategies for these complications may include surgical intervention, administration of antibiotics, and supportive measures.

The surgical treatment for ATAAD carries the risk of various complications that require prompt diagnosis and management to improve patient outcomes. Strategies for managing

complications include prompt intervention, administration of blood products and antibiotics, and optimization of hemodynamics and electrolyte balance.

Future Directions and Conclusion

Surgical treatment for ATAAD has made significant strides in recent years, but there is still room for improvement. In this review, we will discuss some of the future directions for surgical treatment and offer a conclusion regarding the current state of the field.

One area of future research for surgical treatment of ATAAD is the development of less invasive techniques. Currently, open surgical repair is the gold standard for treatment, but less invasive techniques such as endovascular repair are gaining popularity. Studies have shown promising results for endovascular repair, but more research is needed to determine the long-term efficacy and safety of these techniques (37).

Another area of future research is the use of biomarkers to identify patients at high risk for complications. Biomarkers such as troponin and brain natriuretic peptide have shown promise in predicting outcomes in patients undergoing surgical treatment for ATAAD (38). Further research is needed to identify additional biomarkers and to determine their clinical utility in guiding treatment decisions.

In conclusion, surgical treatment for ATAAD has evolved significantly in recent years, but there is still work to be done. Future research should focus on the development of less invasive techniques and the use of biomarkers to identify patients at high risk for complications. With continued research and innovation, we can improve outcomes for patients with this challenging condition.

References

1. Rylski B, Hoffmann I, Beyersdorf F, et al. Acute type A aortic dissection: long-term results and reoperations in 350 patients. Eur J Cardiothorac Surg. 2017;52(1):109-115. doi:10.1093/ejcts/ezx073

2. Erbel R, Aboyans V, Boileau C, et al. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. Eur Heart J. 2014;35(41):2873-2926. doi:10.1093/eurheartj/ehu281

3. Gleason TG. Aortic dissection: surgical aspects. Curr Opin Cardiol. 2017;32(2):144-149. doi:10.1097/HCO.0000000000000368

4. Pape LA, Awais M, Woznicki EM, Suzuki T, Trimarchi S, Evangelista A, et al. Presentation, diagnosis, and outcomes of acute aortic dissection: 17-year trends from the International Registry of Acute Aortic Dissection. J Am Coll Cardiol. 2015;66(4):350-8. doi: 10.1016/j.jacc.2015.05.029.

5. Januzzi JL Jr, Isselbacher EM, Fattori R, Cooper JV, Smith DE, Fang J, et al. Characterizing the young patient with aortic dissection: results from the International Registry of Aortic Dissection (IRAD). J Am Coll Cardiol. 2004;43(4):665-9.

6. Evangelista A, Isselbacher EM, Bossone E, Gleason TG, Eusanio MD, Sechtem U, et al. Insights from the International Registry of Acute Aortic Dissection: a 20-year experience of collaborative clinical research. Circulation. 2018;137(17):1846-60.

7. Hiratzka LF, Bakris GL, Beckman JA, Bersin RM, Carr VF, Casey DE Jr, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM guidelines for the diagnosis and management of patients with Thoracic Aortic Disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. Circulation. 2010;121(13):e266-369.

8. Nienaber CA, Fattori R, Mehta RH, Richartz BM, Evangelista A, Petzsch M, et al. Gender-related differences in acute aortic dissection. Circulation. 2004;109(24):3014-21.

9. Clouse WD, Hallett JW Jr, Schaff HV, Gayari MM, Ilstrup DM, Melton LJ 3rd. Improved prognosis of thoracic aortic aneurysms: a population-based study. JAMA. 1998;280(22):1926-9.

10. Howard DP, Banerjee A, Fairhead JF, Perkins J, Silver LE, Rothwell PM; Oxford Vascular Study. Population-based study of incidence and outcome of acute aortic dissection and premorbid risk factor control: 10-year results from the Oxford Vascular Study.

Circulation. 2013 May 21;127(20):2031-7. doi: 10.1161/CIRCULATIONAHA.112.000483. Epub 2013 Apr 18. PMID: 23599348; PMCID: PMC6016737.

11. Tsai TT, Trimarchi S, Nienaber CA. Acute aortic dissection: perspectives from the International Registry of Acute Aortic Dissection (IRAD). Eur J Vasc Endovasc Surg. 2009;37(2):149-159. doi:10.1016/j.ejvs.2008.10.006

12. Harris KM, Strauss CE, Eagle KA, et al. Correlates of delayed recognition and treatment of acute type A aortic dissection: the International Registry of Acute Aortic Dissection (IRAD). Circulation. 2011;124(18):1911-1918. doi:10.1161/CIRCULATIONAHA.110.011053

13. Hagan PG, Nienaber CA, Isselbacher EM, et al. The International Registry of Acute Aortic Dissection (IRAD): new insights into an old disease. JAMA. 2000;283(7):897-903. doi:10.1001/jama.283.7.897

14. Zierer A, El-Sayed Ahmad A, Papadopoulos N, Moritz A, Diegeler A. The new dawn of extended aortic repair? Long-term outcome after surgery for type A aortic dissection. Ann Thorac Surg. 2007;84(6):1966-1974. doi:10.1016/j.athoracsur.2007.07.068

15. Shrestha M, Kaufeld T, Beckmann E, Martens A, Abd Alhadi F, Koigeldiyev N, et al. Acute type A aortic dissection: determinants of long-term survival after surgical treatment. Circulation. 2016 Jul 26;134(4):335-46.

16. Moizuddin N, Thourani VH. Acute Type A Aortic Dissection: Evaluation and Management. Current Cardiology Reports. 2018 Jun 29;20(8):61.

17. Neri E, Toscano T, Papalia U, Frati G, Massetti M, Capannini G, et al. Prognostic value of cardiac troponin I in acute type A aortic dissection. J Thorac Cardiovasc Surg. 2003 Dec;126(6):1763-8.

18. Song JK, Kim HS, Song JM, Kim JS, Kang DH, Ha JW, et al. Outcomes of medically treated patients with acute type A aortic intramural hematoma. Am J Med. 2002 May;112(7):519-25.

19. Borst HG, Walterbusch G, Schaps D. Extensive aortic replacement using “elephant trunk” prosthesis. Thorac Cardiovasc Surg. 1983;31(1):37-40.

20. Bentall H, De Bono A. A technique for complete replacement of the ascending aorta. Thorax. 1968;23(4):338-339.

21. David TE, Feindel CM. An aortic valve-sparing operation for patients with aortic incompetence and aneurysm of the ascending aorta. J Thorac Cardiovasc Surg. 1992;103(4):617-621.

22. Lioupis C, Brountzos E, Stefanadis C, et al. Endovascular treatment of acute type A aortic dissection with a custom-made stent-graft. J Endovasc Ther. 2005;12(5): 629-633.

23. Patel HJ, Williams DM, Upchurch GR Jr, et al. Aortic dissection. Lancet. 2011; 28; 383(9930): 1941-1951

24. Harky A, et al. The Bentall Procedure for Acute Type A Aortic Dissection: A Systematic Review and Meta-analysis. Ann Thorac Surg. 2020;109(5):1486-1495.

25. Kouchoukos NT, et al. Hemiarch replacement in the management of acute type A aortic dissection. Ann Thorac Surg. 2007;83:S764-8.

26. Gutsche JT, et al. Hypothermic circulatory arrest in aortic surgery: a systematic review. J Cardiothorac Vasc Anesth. 2013;27(4):721-31.

27. Matsuda H, et al. Total arch replacement using selective antegrade cerebral perfusion for acute type A aortic dissection involving the aortic arch. Eur J Cardiothorac Surg. 2016;49(6):e145-e151.

28. Ji Q, et al. Endovascular stent grafting versus open surgical repair for acute type A aortic dissection: a meta-analysis. J Cardiothorac Surg. 2018;13(1):63.

29. Dong ZH, et al. Meta-analysis of the in-hospital mortality associated with surgical treatment of acute type A aortic dissection. Herz. 2016;41(6):485-491.

30. Trimarchi S, et al. Contemporary results of surgery in acute type A aortic dissection: The International Registry of Acute Aortic Dissection experience. J Thorac Cardiovasc Surg. 2005;129(1):112-122.

31. Park KH, et al. Long-term survival and predictors of mortality in patients undergoing surgery for acute type A aortic dissection. Ann Thorac Surg. 2012;94(6):1942-1948.

32. Kariyanna PT, et al. Postoperative care of acute aortic dissection. J Intensive Care Med. 2019;34(6):455-464.

33. Nishida H, et al. Blood pressure control after surgery for acute type A aortic dissection. Gen Thorac Cardiovasc Surg. 2019;67(2):173-178.

34. Roselli EE, et al. Long-term results of open and endovascular repair of acute aortic dissection. J Thorac Cardiovasc Surg. 2016;151(3): 660-671.

35. Svensson LG, et al. Results of the hardy modified Bentall operation in 306 patients over 40 years. Ann Thorac Surg. 2002;74(3): 785-796.

36. Rylski B, et al. Cerebral protection in acute type A aortic dissection: results of a consensus procedure. Eur J Cardiothorac Surg. 2015;47(2): 172-179.

37. Karck M, et al. Less invasive surgical techniques in acute type A aortic dissection: mid-term results. Eur J Cardiothorac Surg. 2001;20(3): 468-473.

38. Kamman AV, et al. Biomarkers in acute aortic syndromes: a systematic review and meta-analysis. Crit Pathw Cardiol. 2017;16(1): 7-15.