Case Series

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Surgery Section

Clinical Outcomes and Technical Considerations in the Surgical and Endovascular Management of Ascending Aortic and Aortic Arch Aneurysms: A Case Series

B NEMBIAN RAJA RAJAN[1], GURUSWAMY NARAYANAN PRABHU[2], SRINATH DAMODARAN[3], AS HARIHARAN[4], SUJIT VELAYUDHAN[5]

ABSTRACT

Aneurysms of the ascending aorta and aortic arch represent one of the most surgically challenging domains in cardiothoracic practice. Contemporary management requires a hybrid strategy integrating conventional open surgery, staged procedures, and Thoracic Endovascular Aortic Repair (TEVAR). This case series presents the institutional experience with six patients who underwent diverse surgical and endovascular interventions for aortic aneurysmal disease, highlighting surgical technique, perioperative complexity, and clinical outcomes. Six patients (age range 30-65 years; four males, two females) presented with aortic pathologies including ascending aortic aneurysm, aortic arch aneurysm, descending thoracic aortic aneurysm, and chronic Type B aortic dissection. Procedures included Aortic Valve Replacement (AVR) with ascending aorta replacement (Dacron graft), total arch replacement with the elephant trunk technique followed by staged TEVAR, carotid artery debranching with staged TEVAR, hemiarch replacement with innominate artery re-implantation, and emergency aortic debranching with TEVAR for complicated dissection. Five of six patients were discharged in haemodynamically stable condition with satisfactory postoperative recovery and continued well-being confirmed at outpatient follow-up. One patient died due to retrograde Type A aortic dissection with coronary extension and cardiac tamponade on postoperative day 10. A multidisciplinary, heart-team-based approach with careful patient selection, staged procedural planning, and individualised intraoperative strategy achieves acceptable outcomes even in complex aortic pathologies. TEVAR combined with surgical debranching provides a viable hybrid alternative in high-risk patients. Mortality risk persists in retrograde dissection, underscoring the need for vigilant surveillance.

Keywords: Aortic dissection, Endovascular procedures, Heart valve prosthesis implantation, Thoracic aortic diseases, Treatment outcome

INTRODUCTION

Aortic aneurysmal disease involving the ascending aorta and arch constitutes a significant proportion of cardiovascular surgical volume in tertiary care centres. The natural history of untreated thoracic aortic aneurysms is progressive dilatation culminating in rupture or dissection, with an annual risk of catastrophic complication estimated at 2-3% for aneurysms below 5 cm and exceeding 7% for those above 6 cm [1,2]. The surgical management of these lesions has evolved considerably over the past three decades, moving from purely open repairs under Deep Hypothermic Circulatory Arrest (DHCA) to sophisticated hybrid approaches combining open surgical debranching with Thoracic Endovascular Aortic Repair (TEVAR) [3].

The complexity of aortic arch surgery arises from the necessity of ensuring adequate cerebral protection, achieving complete exclusion of the aneurysmal segment, and managing concomitant pathologies such as valvular disease, coronary artery disease, chronic kidney disease, and pulmonary compromise. Total arch replacement with the elephant trunk technique, popularised by Borst HG et al., allows staged treatment of extensive thoracoabdominal aneurysms and has significantly improved outcomes in what was previously a uniformly lethal condition [4].

In Indian surgical practice, the epidemiological profile of aortic aneurysm patients differs from western cohorts, with a significant proportion attributable to rheumatic valvular disease, longstanding poorly controlled hypertension, and late-presenting degenerative aneurysms [5]. The management of these patients in a resource-conscious environment demands not only technical expertise but also judicious planning of staged versus single-stage approaches.

This case series from the Institute of Cardiac Sciences, SRM Medical College Hospital & Research Centre, Chennai, presents six patients with diverse aortic pathologies managed between 2023 and 2025. The clinical presentations, operative strategies, intraoperative challenges, and outcomes are described, with the intent of contributing institutional data to the growing body of evidence on hybrid and staged aortic repair in the Indian context.

CASE SERIES

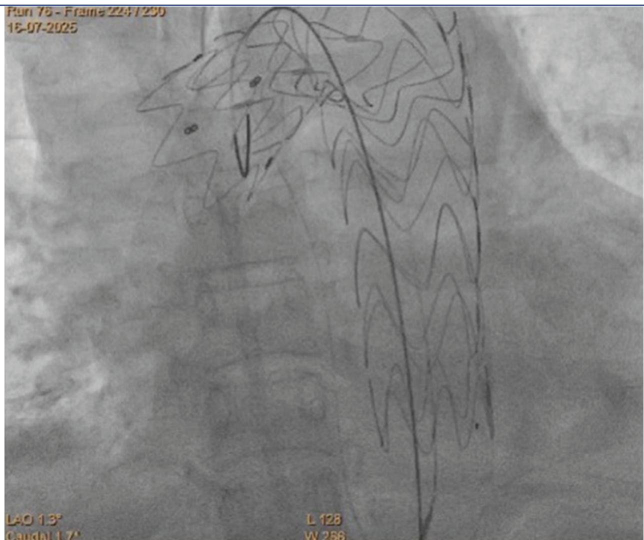
Case 1: Descending Aortic Arch Aneurysm- Staged Carotid Debranching and TEVAR

A 61-year-old male with Type 2 Diabetes Mellitus (T2DM) and Systemic Hypertension (SHTN), both of five years duration and on regular medication, presented with hoarseness of voice persisting for three months. The patient remained symptomatic at presentation, was under concurrent Ear, Nose and Throat (ENT) follow-up for the same complaint and on medication, with a Contrast-Enhanced Computed Tomography (CECT) of the neck planned for further evaluation; CT was undertaken in this context to evaluate the hoarseness alongside suspected mediastinal pathology. Evaluation revealed a partially thrombosed large saccular aneurysm of the aortic arch just distal to the origin of the left subclavian artery on CT aortogram. Additionally, the patient was found on this admission to have a single functioning left kidney secondary to a severely narrowed calibre of the right renal artery with a shrunken right kidney- a critical anatomical consideration for contrast-based procedures and renal preservation.

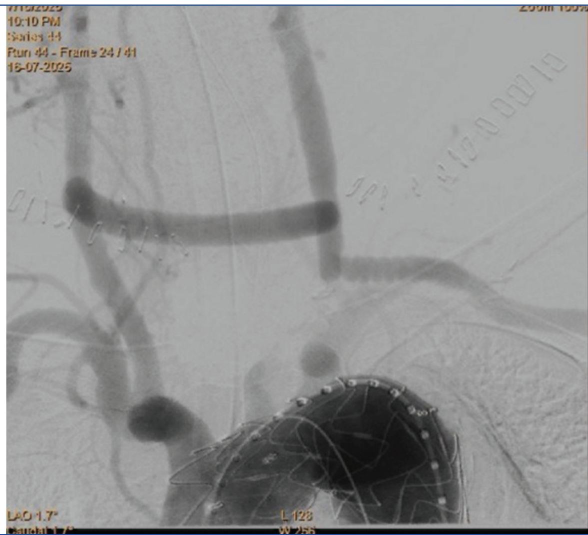
The CT cerebral angiography revealed mild age-related cerebral atrophy, a chronic infarct in the right gangliocapsular region, and chronic infarcts in the left thalamus and left hemi-pons, indicating pre-existing cerebrovascular disease. Pre-operative 2D echocardiography demonstrated a dilated aortic arch (4.2 cm), concentric Left Ventricular Hypertrophy (LVH), and preserved Left Ventricular Ejection Fraction (LVEF) of 60%. Coronary angiography confirmed normal coronaries. Nephrologist and Neuromedicine fitness were obtained in view of these co-morbidities.

After multidisciplinary heart team discussion, a two-stage procedure was planned. Stage I: right carotid to left carotid bypass followed by left carotid to left subclavian artery bypass under general anaesthesia was performed to ensure adequate cerebral and upper limb perfusion prior to endograft deployment [Table/Fig-1a]. Stage II: TEVAR under fluoroscopic guidance with vascular plug occlusion of the origin of the left subclavian artery, successfully excluding the aneurysmal sac [Table/Fig-1b,c]. Intraoperative blood loss was approximately 300 mL, with one unit of Packed Red Blood Cells (PRBC) transfused.

[Table/Fig-1a]: Post neck vessel debranching fluoroscopic image showing an intact Polytetrafluoroethylene (PTFE) graft anastomosis between the right and left carotid arteries, and the left carotid to left subclavian artery bypass.



[Table/Fig-1b]: TEVAR stent in situ.



[Table/Fig-1c]: Fluoroscopic image showing TEVAR successfully excluding the aneurysmal sac, with vascular plug occlusion of the origin of the left subclavian artery.

Postoperatively, the patient was shifted to the Cardiothoracic and Vascular Surgery Intensive Care Unit (CTVS ICU) in haemodynamically stable condition. Neck Doppler on Post-operative Day 1 (POD-1) confirmed satisfactory flow through the bypass grafts. The patient was extubated, shifted to the ward on POD-3, and made a gradual uneventful recovery. He was discharged on POD-10 in stable condition and remains asymptomatic on outpatient follow-up.

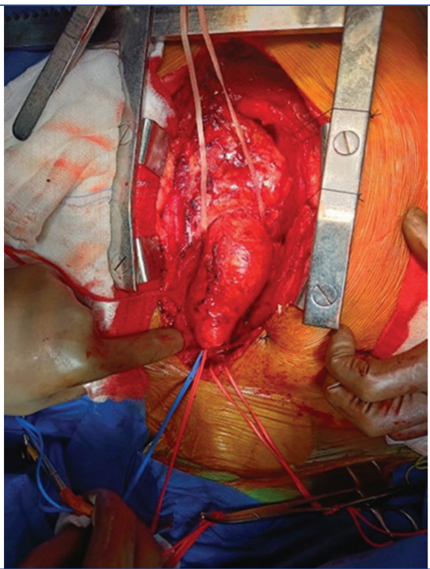
Case 2: Ascending Aortic and Innominate Artery Aneurysm - Redo Sternotomy with Hemiarch Replacement

A 30-year-old male with a history of Aortic Valve Replacement (AVR) in March 2011 and SHTN was found to have a dilated ascending aorta (4.94 cm) on routine echocardiographic follow-up. He was asymptomatic, with no chest pain, dyspnoea, palpitations, or syncope. Physical examination revealed a valve click. Pre-operative echocardiography demonstrated a functioning mechanical prosthetic valve with a peak gradient of 32 mmHg, trivial paravalvular regurgitation, concentric LVH, and LVEF of 67%. CT aortogram confirmed increased calibre of the ascending aorta and proximal arch, consistent with post-regurgitation dilatation, and also identified an innominate artery aneurysm [Table/Fig-2a].

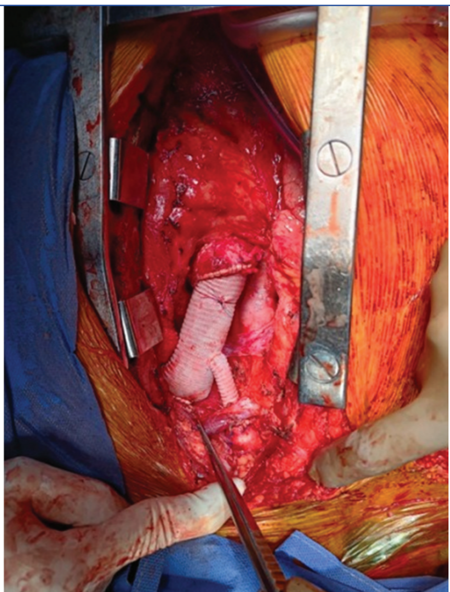

[Table/Fig-2a]: CT aortogram showing increased calibre of the ascending aorta and proximal arch, consistent with post-regurgitation dilatation, and an innominate artery aneurysm.

The operative challenge in this case was substantial: redo median sternotomy carries significantly higher risk due to pericardial adhesions, risk of injury to patent bypass grafts or the prosthetic valve, and difficult haemostasis. The patient's pre-existing oral anticoagulation (Tablet Acitrom 2 mg daily for the mechanical prosthesis) was bridged with intravenous heparin in the immediate pre-operative period; heparin was discontinued prior to surgery, and anticoagulation was reinstituted with Acitrom postoperatively once haemostasis was secure. Protamine was administered intraoperatively for heparin reversal following cardiopulmonary bypass. After thorough pre-operative planning and anaesthetic optimisation including hypertension control, the patient underwent ascending aorta and hemiarch replacement with innominate artery re-implantation through redo median sternotomy [Table/Fig-2b,c], performed under systemic cooling to 24°C with a total circulatory arrest time of 55 seconds and retrograde cerebral perfusion delivered over two cycles (18 minutes). Cardiopulmonary bypass time was 189 minutes, with an aortic cross-clamp time of 134 minutes.

Neurological monitoring was performed intraoperatively using Near-Infrared Spectroscopy (NIRS). Intraoperative blood loss was approximately 300 mL, with two units of PRBC and two units of Fresh Frozen Plasma (FFP) transfused. The patient was extubated on POD-1, and the Intercostal Chest Drain (ICD) was removed on POD-3. In view of an elevated total leucocyte count, antibiotics were escalated to Injection Meropenem and Injection Targocid. The patient was ambulated on POD-2 and completed an uneventful recovery. Postoperative echocardiography confirmed a well-functioning mechanical prosthetic valve with a mean gradient of 7 mmHg, no periprosthetic graft leak, and preserved LV function (Ejection Fraction (EF) 60%). He was discharged on POD-9 and remains under regular outpatient surveillance in good health.



[Table/Fig-2b]: Intraoperative image of the ascending aortic aneurysm with innominate artery aneurysm and unhealthy aortic wall.



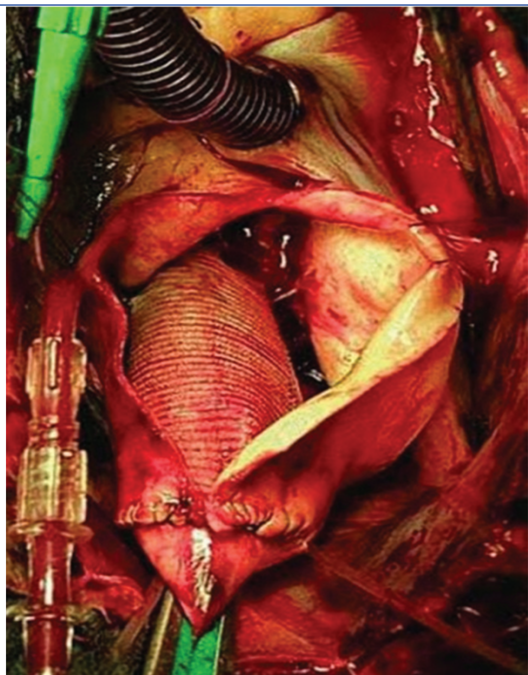
[Table/Fig-2c]: Intraoperative image after resection of the ascending aortic aneurysm with innominate artery aneurysm, repaired with a composite PTFE graft.

Case 3: Severe Aortic Stenosis with Dilated Ascending Aorta- AVR and Ascending Aorta Replacement

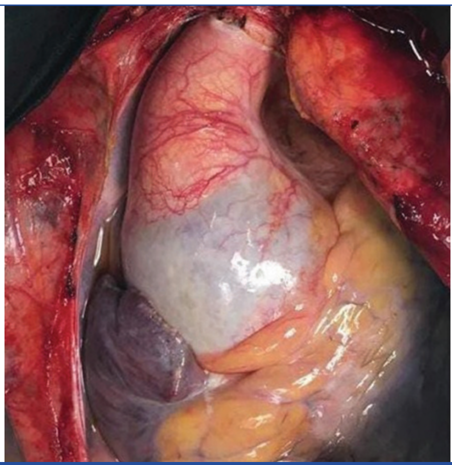
A 52-year-old female with rheumatic heart disease of 36 years' duration and severe aortic stenosis presented with shortness of breath and palpitations. She was on regular medications and was referred for AVR. Pre-operative echocardiography demonstrated a calcified aortic valve with severe aortic stenosis (peak gradient 79 mmHg, mean gradient 53 mmHg), a bicuspid aortic valve, dilated ascending aorta of 4.2 cm, concentric LVH, and preserved LVEF of 65%. CT aortogram confirmed post-stenotic dilatation of the ascending aorta, proximal arch, and brachiocephalic artery. Coronary angiography showed normal epicardial coronaries.

Surgery was performed through median sternotomy with a cardiopulmonary bypass time of 130 minutes and an aortic cross-clamp time of 102 minutes. Intraoperative findings revealed severe cardiomegaly (3+), marked LV hypertrophy, a bicuspid aortic valve with severe calcification and commissural fusion, and a dilated ascending aorta measuring 6 cm with an unhealthy aortic wall [Table/Fig-3a]- necessitating aorta replacement. AVR was performed with a 19 mm bioprosthetic valve using horizontal mattress intermittent sutures, and the ascending aorta was replaced with a 22 mm Dacron straight graft using end-to-end anastomosis [Table/Fig-3b] under standard cardiopulmonary bypass with antegrade cardioplegia and topical ice slush. Intraoperative Transoesophageal Echocardiography (TEE) confirmed good LVEF and no paravalvular leak. Intraoperative blood loss was approximately 200 mL, with no blood product transfusion required.

The patient was extubated on POD-1 and drains were removed on POD-2. Postoperative echocardiography confirmed a well-seated bioprosthetic valve with no leak (peak gradient 26 mmHg, mean gradient 12 mmHg), normal LV systolic function (EF 62%), and no pericardial effusion. She was discharged on postoperative day 12 in haemodynamically stable condition with a healthy wound and has continued well on outpatient follow-up.



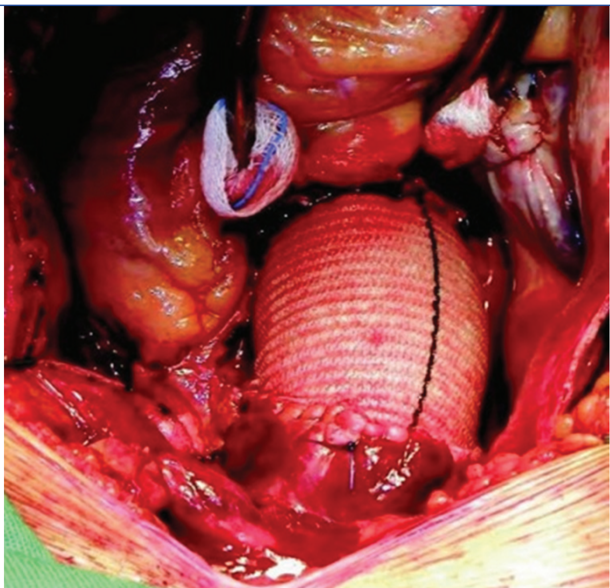
[Table/Fig-3a]: Intraoperative image of the ascending aortic aneurysm with unhealthy aortic wall.



[Table/Fig-3b]: Intraoperative image of the ascending aortic aneurysm replaced with a Dacron graft.

Case 4: Severe Aortic Regurgitation with Ascending Aortic Dilatation- AVR and Aorta Replacement

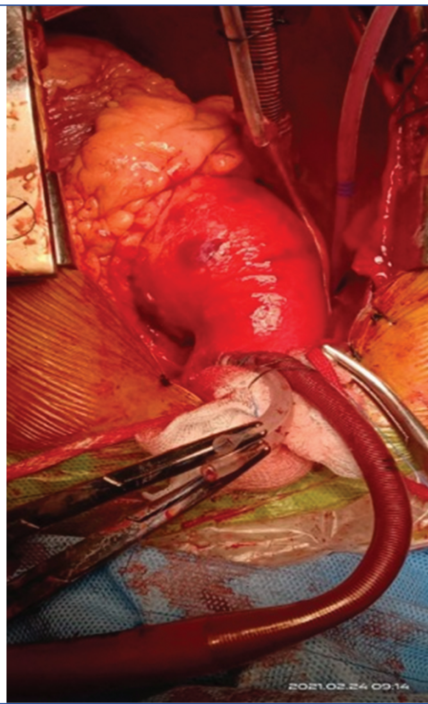
A 65-year-old male with systemic hypertension presented with severe aortic regurgitation, mild aortic stenosis, and a markedly dilated ascending aorta measuring 6.60 cm on echocardiography. He complained of dyspnoea and palpitations. Pre-operative echocardiography confirmed moderate-to-severe aortic regurgitation (LVEF 62%), mild pulmonary hypertension, and grade I diastolic dysfunction. CT aortogram confirmed aneurysmal dilatation of the ascending aorta [Table/Fig-4a]. Coronary angiography showed normal epicardial coronary arteries.



[Table/Fig-4a]: Intraoperative image of the ascending aortic aneurysm prior to repair.

Surgery was performed through median sternotomy with systemic cooling to 28°C, a cardiopulmonary bypass time of 154 minutes, and an aortic cross-clamp time of 108 minutes. The ascending aorta was transected; intraoperative findings confirmed a severely dilated, unhealthy aortic wall (6 cm) mandating aortic replacement. The aortic valve showed thickened, rolled-out leaflets with commissural fusion and severe calcification. AVR was performed with a 21 mm bioprosthetic valve, and the ascending aorta was replaced with a 24 mm Dacron straight graft [Table/Fig-4b]. Intraoperative TEE confirmed satisfactory valve function and no paravalvular leak. Intraoperative estimated blood loss was 600 mL, with two units of PRBC, four units of FFP, and four units of platelets transfused.

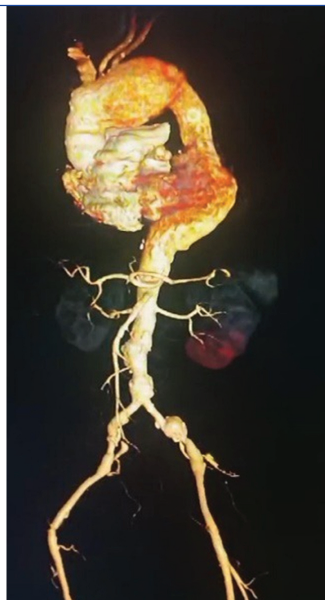
On POD-3, the patient developed new-onset atrial fibrillation with rapid ventricular response, which was successfully cardioverted pharmacologically with Injection Amiodarone 150 mg bolus. Postoperative echocardiography confirmed normal prosthetic valve function (peak gradient 20 mmHg, mean gradient 13 mmHg), preserved LV systolic function (EF 60%), and no paravalvular leak. The remainder of the hospital course was uneventful. He was discharged on POD-11 in stable condition and has continued well on outpatient review.



[Table/Fig-4b]: Intraoperative image following ascending aorta replacement with a Dacron graft.

Case 5: Giant Aortic Arch and Descending Thoracic Aortic Aneurysm- Elephant Trunk Procedure and Staged TEVAR

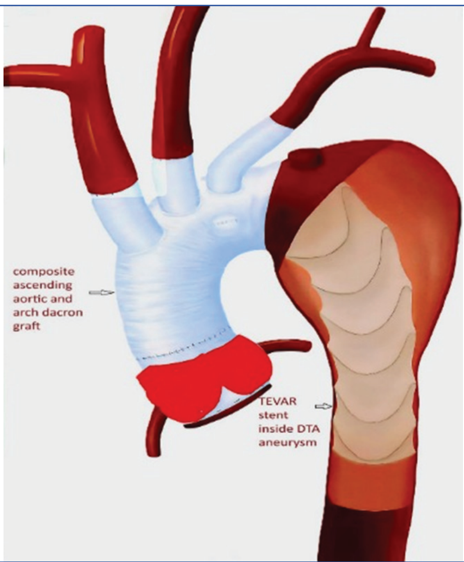
A 64-year-old male with a 30-year smoking history, and SHTN and Chronic Obstructive Pulmonary Disease (COPD) each of 30 years duration, presented with progressive shortness of breath of two months duration. Imaging revealed a giant aneurysm of the aortic arch (diameter 8 cm and length 9 cm) with partial eccentric thrombus and a separate aneurysm of the descending thoracic aorta (diameter 10 cm and length 9 cm), also with eccentric thrombus, without evidence of aortic dissection [Table/Fig-5a]. An incidental fusiform aneurysm of the left common iliac artery was also identified.



[Table/Fig-5a]: CT aortogram showing aneurysmal dilatation of the aortic arch (diameter 8 cm, length 9 cm) with partial eccentric thrombus causing a filling defect, and a separate aneurysm of the descending thoracic aorta (diameter 10 cm, length 9 cm) with eccentric thrombus. No evidence of aortic dissection.

Pre-operative Pulmonary Function Testing (PFT) demonstrated mild restriction, and CT chest confirmed centrilobular emphysematous changes predominantly in the upper lobes.

In view of the anatomical complexity (giant arch and descending thoracic aortic aneurysm), a two-stage hybrid approach was planned. Stage I: total arch replacement and ascending aortic replacement using the Elephant Trunk technique through median sternotomy [Table/Fig-5b]- A procedure that deploys a free-floating graft segment ('trunk') into the descending aorta as a landing zone for subsequent TEVAR. The frozen elephant trunk technique was not employed in this case; the conventional elephant trunk approach was selected to allow staged completion once the patient's pulmonary status, optimised pre-operatively in view of his COPD, permitted a second procedure. Stage I was performed with an aortic cross-clamp time of 175 minutes and a total circulatory arrest time of 65 minutes.

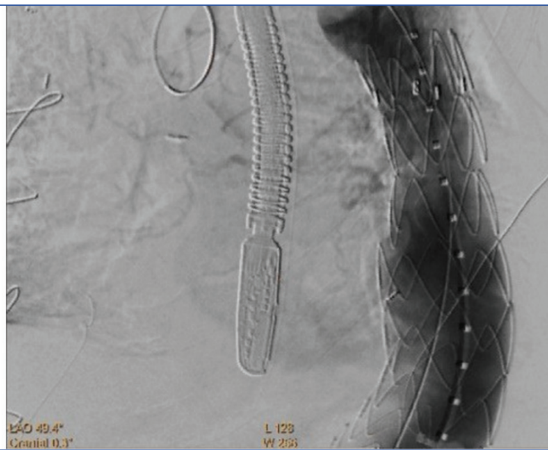


[Table/Fig-5b]: Illustration of total arch and ascending aortic replacement using the Elephant Trunk technique, in which a free-floating graft segment ('trunk') is deployed into the descending aorta to serve as a landing zone for subsequent Thoracic Endovascular Aortic Repair (TEVAR).

The postoperative course was demanding; on POD-1 the patient developed Generalised Tonic-Clonic Seizures (GTCS) requiring anti-epileptic therapy as per neurology guidance. CECT cerebral angiography performed to characterise the aetiology showed bilateral intracranial internal carotid, anterior, middle and posterior cerebral, and basilar arteries of normal calibre with no stenosis or vascular malformation; the anterior and posterior communicating arteries appeared normal, and the A1 segment of the right anterior cerebral artery was hypoplastic. No acute territorial infarction, haemorrhage, or space-occupying lesion was identified, and the study was reported as a normal cerebral angiogram- favouring a metabolic or hypoperfusion-related rather than embolic or structural aetiology for the seizure episode, though clinical correlation was advised. Pulmonology input was obtained for early Acute Respiratory Distress Syndrome (ARDS) prevention. The patient required tracheostomy on day 6 for prolonged mechanical ventilation. Post-operative CT aortogram confirmed an intact arch graft with no leak and a partially thrombosed descending thoracic aortic aneurysm. Intraoperative blood loss for Stage I was approximately 450 mL, with one unit of PRBC, two units of FFP, and two units of platelets transfused.

After clinical stabilisation, Stage II: TEVAR was performed via right femoral artery cutdown [Table/Fig-5c]. A Medtronic Valiant Thoracic Captiva endograft (36 mm diameter × 207 mm length) was deployed across the descending thoracic aortic aneurysm using Lunderquist extra-stiff wire guidance, meticulously avoiding celiac trunk occlusion. Post-deployment aortogram confirmed good stent opposition with no endoleak and no major arterial occlusion [Table/Fig-5d].

[Table/Fig-5c]: Fluoroscopic image showing the intact Elephant Trunk procedure with the descending thoracic aortic aneurysm prior to TEVAR completion.



[Table/Fig-5d]: Fluoroscopic image showing successful TEVAR of the descending thoracic aortic aneurysm.

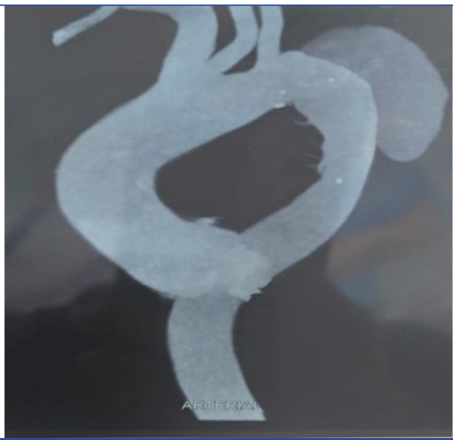
The patient subsequently weaned off ventilation, was decannulated, and orthostatic hypotension was managed with Midodrine. He was discharged on day 29 in stable condition. Left common iliac aneurysm repair was deferred to a subsequent planned procedure. He remains well on follow-up.

Case 6: Chronic Type B Aortic Dissection with Penetrating Atherosclerotic Ulcer (PAU) - Hybrid TEVAR (Fatal Outcome)

A 58-year-old female presented with left-sided chest pain radiating to the upper back for three months, associated with approximately 5 kg of weight loss and episodic fever. She had been evaluated at a local hospital, where a diagnosis of Type B aortic dissection with proximal thoracic aortic dilatation, additional dissection at the left renal artery, PAU of the left subclavian artery and descending thoracic aorta, and a bovine aortic arch configuration was established. The patient discharged herself against medical advice and presented to the outpatient department for further management.

On admission, cardiac evaluation confirmed Type B aortic dissection with a flap in the false lumen extending beyond the left subclavian artery with a bovine arch. The patient developed fever spikes; urine culture grew Enterococcus species, and appropriate culture-sensitive antibiotics were commenced in consultation with the Infectious Diseases team. CT Kidney Ureter Bladder (KUB) revealed a small left kidney with cortical scarring. Pre-procedural CT cerebral angiography identified a small outpouching from the left subclavian artery and confirmed the bovine arch configuration. Following haematological optimisation with intravenous iron for anaemia, the multidisciplinary heart team approved a staged hybrid approach [Table/Fig-6a].

Stage I: Aortic arch debranching—left subclavian artery to left common carotid artery bypass [Table/Fig-6b] was performed in the

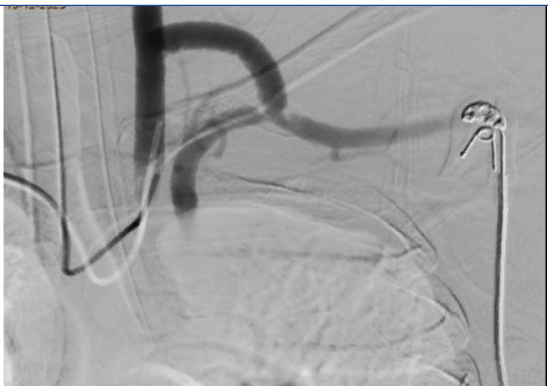


[Table/Fig-6a]: CT aortogram showing Type B aortic dissection with a flap in the false lumen extending beyond the left subclavian artery, with a bovine arch configuration.

[Table/Fig-6b]: Fluoroscopic image showing aortic arch debranching- left subclavian to left common carotid artery bypass.

catheterisation laboratory under general anaesthesia after coronary angiography confirmed normal epicardial coronaries. The procedure was uneventful.

Stage II: TEVAR was performed on postoperative day 3 following the debranching procedure [Table/Fig-6c], under general anaesthesia, and was uneventful. The patient was extubated and mobilised bedside with haemodynamic stability.



[Table/Fig-6c]: Fluoroscopic image showing successful TEVAR and successful neck vessel debranching.

On postoperative day 8 following TEVAR (POD-11 overall, calculated from the Stage I debranching procedure), the patient developed sudden ptosis and left upper and lower limb weakness. CT brain confirmed small bilateral lacunar infarcts in the internal capsule region. CT neck and cerebral angiography revealed markedly reduced flow in the right common carotid and vertebral arteries with intimal dissection, and aortic intimal dissection suggesting aneurysmal changes- a pattern consistent with retrograde Type A extension. Repeat echocardiography at 09:00 hours confirmed a new dissection flap in the ascending aorta extending to the aortic root with moderate aortic regurgitation and preserved ejection fraction. Emergency surgical intervention (ascending aortic repair/ Bentall procedure) was planned. However, at 12:30 hours while transferring to the cardiac operation theatre, the patient developed sudden bradycardia and profound hypotension. Emergency sternotomy was performed; pericardiocentesis revealed 500 g of clot consistent with cardiac tamponade. A 1.5×1.5 cm rent was identified at the posterior aspect of the aortic root. Despite 45 minutes of intracardiac massage and multiple defibrillation attempts, Return of Spontaneous Circulation (ROSC) could not be achieved. The patient was declared clinically dead. Intraoperative blood loss prior to the terminal event was approximately 150 mL, with one unit of PRBC transfused. Cause of death was Type A aortic dissection with coronary extension and cardiac tamponade in a postoperative case of TEVAR with left subclavian debranching for chronic Type B aortic dissection.

Summary of all the cases is presented in [Table/Fig-7].

DISCUSSION

This case series illustrates the breadth of aortic aneurysmal pathology encountered in a tertiary cardiac centre and the requirement for individualised, multidisciplinary management strategies. The six cases collectively represent ascending aortic aneurysm with concomitant valvular disease, aortic arch aneurysm managed by debranching and TEVAR, total arch reconstruction with the Elephant Trunk technique, and complicated Type B dissection treated by hybrid endovascular repair.

Ascending aortic aneurysms in association with valvular disease- whether stenosis or regurgitation- represent the most commonly encountered combination in this series, as reflected by Cases 3 and 4. According to the American College of Cardiology/ American Heart Association (ACC/AHA) and European Society of Cardiology (ESC) guidelines concurrent aortic root/ascending aorta replacement is recommended, at the time of aortic valve surgery when the aortic diameter exceeds 4.5 cm in the presence of bicuspid aortic valve or 5.0 cm in degenerative tricuspid disease [6,7]. Both patients in this series exceeded these thresholds at surgery, with intraoperative findings of unhealthy aortic walls and severe calcification confirming the appropriateness of concomitant repair. Aortic root reconstruction during valve surgery is associated with increased operative risk [8].

The Elephant Trunk procedure employed in Case 5 is a well-established technique for the management of extensive thoracoabdominal aneurysms. First described by Borst HG et al., in 1983 and subsequently refined by multiple groups, it allows total arch reconstruction at Stage I while providing a landing zone in the descending aorta for Stage II endovascular completion [4,9]. Postoperative neurological complications are recognised following proximal aortic surgery, with temporary neurological dysfunction and stroke reported in 5.9% and 4.3% of patients, respectively [10]. In this case, a structurally normal cerebral angiogram favoured a metabolic or hypoperfusion mechanism over an embolic or structural one. Its management with anti-epileptic therapy and prolonged ventilatory support until neurological clarity was achieved represents standard practice. The need for tracheostomy highlights the importance of pulmonary rehabilitation protocols, especially given this patient's pre-existing COPD. His ultimate recovery and successful Stage II TEVAR completion is a testament to the multidisciplinary critical care management achievable even in physiologically compromised patients.

The hybrid debranching-TEVAR approach employed in Case 1 is particularly relevant in the Indian context, where patients may present with complex anatomy, significant co-morbodities, or high operative risk for total arch replacement. This is consistent with the findings of Sai Krishna C et al., who, in their single-centre Indian experience, similarly emphasised staged and

Case	Age/Gender	Diagnosis	Procedure	Outcome	Follow-up
Case 1	61 Y/M	Descending Aortic Arch Aneurysm, T2DM, SHTN, Single Functioning Kidney (L)	Stage I: Rt Carotid–Lt Carotid Bypass + Lt Carotid–Lt Subclavian Bypass; Stage II: TEVAR	Discharged on POD-10 Stable	Reviewed at CTVS OPD; Healthy
Case 2	30 Y/M	Ascending Aortic Aneurysm + Innominate Artery Aneurysm; S/P AVR (2011), SHTN	Ascending Aorta + Hemiarch Replacement + Innominate Artery Re-implantation (Redo Sternotomy)	Discharged on POD-9 Stable	Reviewed at CTVS OPD; Healthy
Case 3	52 Y/F	Severe Aortic Stenosis with Dilated Ascending Aorta (RHD)	AVR (19 mm Bioprosthetic) + Ascending Aorta Replacement (22 mm Dacron graft)	Discharged on POD-12 Stable	Reviewed at CTVS OPD; Healthy
Case 4	65 Y/M	Severe AR + Mild AS + Ascending Aorta Dilation (6.60 cm), Hypertension	AVR (21 mm Bioprosthetic) + Ascending Aorta Replacement (24 mm Dacron graft)	Discharged on POD-11 Stable (POD-3 AF managed)	Reviewed at CTVS OPD; Healthy
Case 5	64 Y/M	Giant Aortic Arch + Descending Thoracic Aorta Aneurysm, COPD, SHTN, Lt Iliac Artery Aneurysm	Stage I: Total Arch + Ascending Aorta Replacement (Elephant Trunk); Stage II: TEVAR	Discharged on POD-29, Stable (complex ICU course)	Reviewed at CTVS OPD; Healthy
Case 6	58 Y/F	Chronic Type B Aortic Dissection with PAU, Bovine Arch	Stage I: Left Subclavian Debranching + Lt Carotid–Subclavian Bypass; Stage II: TEVAR	Died on POD-11 (Retrograde Type A Dissection, Coronary Extension and Cardiac	N/A (Deceased)

[Table/Fig-7]: Summary of patient demographics, diagnoses, procedures, and outcomes.
Y: Years; M: Male; F: Female; T2DM: Type 2 Diabetes Mellitus; SHTN: Systemic Hypertension; Rt: Right; Lt: Left; TEVAR: Thoracic Endovascular Aortic Repair; AVR: Aortic Valve Replacement; RHD: Rheumatic Heart Disease; AR: Aortic Regurgitation; AS: Aortic Stenosis; COPD: Chronic Obstructive Pulmonary Disease; PAU: Penetrating Atherosclerotic Ulcer; POD: Postoperative Day; CTVS OPD: Cardiothoracic and Vascular Surgery Outpatient Department.

hybrid strategies to extend aortic repair to high-risk patients unsuitable for conventional open total arch surgery. Despite a patient population with substantial comorbidities, they reported outcomes broadly comparable to those observed in the present case series [5]. Carotid-to-carotid and carotid-to-subclavian bypasses, followed by TEVAR with vascular plug occlusion of the origin of the revascularised vessel, allow complete exclusion of arch aneurysms with reduced physiological insult compared to open arch repair [11,12]. The importance of pre-operative Doppler confirmation of graft flow, as performed in this case, is a critical quality check that should be part of the standardised postoperative pathway.

Case 2 presented a unique technical challenge: ascending aortic aneurysm with innominate artery involvement requiring hemiarch replacement via redo sternotomy in a young patient with a prior mechanical AVR. Reoperative valve replacement is associated with an increased operative risk, with mortality influenced by the type and urgency of reoperation [13]. The use of intraoperative NIRS for cerebral monitoring, defined circulatory arrest and retrograde cerebral perfusion parameters, and judicious peri-operative heparin bridging of the patient's mechanical-valve anticoagulation were critical elements of this case. The excellent neurological and haemodynamic outcome achieved in this young patient underscores the value of detailed pre-operative planning and experienced operative execution.

The fatal outcome in Case 6 illustrates the most feared complication following TEVAR for Type B aortic dissection—retrograde Type A aortic dissection (RTAD). This complication, reported in 1.3-2.5% of TEVAR procedures for Type B dissection, arises from traumatic injury to the aortic intima at the proximal landing zone of the endograft, propagating retrogradely into the ascending aorta and aortic root [14,15]. Risk factors include extensive dissection, inadequate proximal landing zone, high oversizing of the graft, and inherent aortic fragility. In the present case, the combination of a bovine aortic arch, a PAU, chronic dissection, and pre-existing systemic infection likely contributed to aortic wall vulnerability. The progression from neurological deficits to cardiac tamponade within hours exemplifies the fulminant natural history of this complication. Prompt echocardiographic surveillance and a low threshold for emergency re-operation are mandatory; however, even with optimal response, outcomes remain dismal once aortic root rupture has occurred [16].

The outcomes of the present series, comprising five successful discharges and one death due to a recognised complication, are comparable with outcomes reported in an Indian single-centre experience of aortic aneurysm surgery [5,17]. The mortality rate of 16.7% (1/6) in a cohort enriched with complex re-operative, hybrid, and emergent procedures is contextually acceptable, though every effort must be made to further reduce this through refined patient selection, improved endograft technology, and standardised surveillance protocols. Within this series, the Indian context manifested concretely in patient-level factors rather than only as a backdrop: rheumatic valvular involvement in a relatively young patient (Case 3), prolonged, often-delayed disease courses prior to definitive referral (Cases 1, 3 and 6), and resource-conscious staged strategies adopted specifically to extend repair to patients who would otherwise be deemed unfit for single-stage open total arch surgery.

Several lessons emerge from this series. First, meticulous preoperative imaging with multi-modality assessment (echocardiography, CT aortogram, cerebral angiography, Doppler studies) is non negotiable in all aortic aneurysm patients. Second, a heart team approach incorporating cardiology, cardiac surgery, cardiac anaesthesia, neurology, nephrology, and intensive care is essential for complex cases. Third, staged procedures- whether open followed by TEVAR or debranching followed by TEVAR- allow optimisation of physiological reserve between stages, reducing cumulative operative risk. Fourth, post-TEVAR surveillance with echocardiography and cross-sectional imaging must be vigilant, particularly in the early postoperative period when retrograde dissection risk is highest.

CONCLUSION(S)

The present institutional case series demonstrates that a wide spectrum of ascending aortic and aortic arch aneurysmal pathologies can be successfully managed through individualised surgical and hybrid endovascular strategies in a dedicated cardiac surgical programme. Open AVR with concomitant ascending aortic replacement, total arch reconstruction using the Elephant Trunk procedure with staged TEVAR, and hybrid carotid debranching with TEVAR each address distinct anatomical and physiological challenges. Multidisciplinary planning, meticulous surgical execution, and comprehensive postoperative monitoring collectively drive favourable outcomes. Retrograde Type A dissection following TEVAR for Type B disease remains a life-threatening complication demanding immediate recognition and intervention. Continued accumulation of institutional data and contribution to national registry efforts are essential to refine guidelines for aortic surgery in the Indian patient population.

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PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Cardiothoracic and Vascular Surgery, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
2. Consultant, Department of Cardiothoracic and Vascular Surgery, Sir Ivan Stedeford Hospital, Chennai, Tamil Nadu, India.
3. Consultant, Department of Cardiac Anaesthesia, SRM Global Hospitals, Chennai, Tamil Nadu, India.
4. Consultant, Department of Cardiothoracic and Vascular Surgery, Frontier Lifeline Hospital, Chennai, Tamil Nadu, India.
5. Consultant, Department of Cardiothoracic and Vascular Surgery, SRM Global Hospitals, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
B Nembian Raja Rajan,
601, B-Block Medical Staff Quarters, SRM Nagar, Potheri, Chennai-603203,
Tamil Nadu, India.
E-mail: nembianr@srmist.edu.in

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