CASE REPORTS

ANESTHETIC MANAGEMENT INTEGRATED IN "AORTA TEAM" APPROACH FOR TOTAL ENDOVASCULAR AORTIC ARCH REPAIR: A CASE SERIES

Ana Margarida Martins[1]*, Filipa Aguiar[1], Ana Ferro[1]

[1] Anesthesiology Department, Local Health Unit of São José, Lisbon, Portugal

* **Corresponding author**: ana.marga.vm@hotmail.com

Abstract

Total endovascular aortic arch repair is nowadays a promising alternative for selected patients with aortic arch disease. These endovascular procedures are technically challenging and require a diligent planning among all members of a multidisciplinary "Aorta Team" integrating cardiovascular anesthesiologists. In fact, endovascular aortic arch repair is a major challenge for anesthesiologists because of the risk of hemodynamic instability, cerebral events and acute kidney injury. In order to achieve the success, it is fundamental to discuss each patient in an individual basis, including perioperative management and care, and to be aware of surgical steps and their potential complications. Considering our previous experience with endovascular thoracoabdominal aortic surgery, we herein summarize our experience with anesthetic management of patients who underwent total endovascular aortic arch repair and its principal outcomes.

Keywords: *Endovascular Aneurysm Repair, Anesthesia, Perioperative Care, Aortic Arch Aneurysm*

INTRODUCTION

Total endovascular aortic arch repair (TEAAR) is an emerging treatment alternative for selected patients with aortic arch disease, particularly those at high surgical risk for open surgical repair[1].

Endovascular surgery has advantages over open repair as they are minimally invasive and do not require cardiopulmonary bypass, aortic cross-clamping, or hypothermic circulatory arrest, thus avoiding their potential complications[2]. However, unique aspects of endovascular surgery have their own anesthetic implications.

The success of these procedures is partly ensured by the existence of multidisciplinary "Aortic Teams" integrating vascular and cardiac surgeons, and cardiovascular anesthesiologists.

We present a series of five patients who underwent TEEAR at a Portuguese referral center from 2021 to 2023. Our aim is to identify specific anesthetic implications, potential complications, and the outcomes of these first patients who underwent TEAAR.

CASE SERIES

Total of five consecutive patients submitted to elective TEAAR from October 2021 to December 2023 for correction of aortic arch sacular aneurysm.

Patients were previously evaluated by a multidisciplinary Aorta Team and deemed unfit for traditional open arch repair.

The correction of aortic arch aneurysm was performed in a two stage procedure - surgical left carotid-subclavian bypass performed first (adjunctive procedure) and TEAAR (primary procedure).

Regarding anesthetic approach of TEAAR, all procedures were under balanced general anesthesia with endotracheal tube. All patients were monitored with standard ASA monitors, invasive blood pressure monitoring (arterial line placed in the right radial artery), bilateral bispectral index, continuous cerebral oximetry monitoring and transesophageal echocardiogram (TEE). Central venous access was also obtained in the left femoral vein - introduced by surgeons after surgical sterilization and before

Table 1 **Baseline characteristics of the study cohort**

Case	Age (years)	Sex	Height (cm)	Weight (cm)	Comorbidities	ASA Classification
1	77	Male	170	70	HTN, Ex-tobacco use, rAAA repair by EVAR+ Femoral cross-over	III
2	81	Male	165	80	HTN, HLD, Ex-tobacco use, hearing impairment.	III
3	77	Male	175	89	HTN, HLD, AFl, PPM	III
4	71	Male	163	76	HTN, DM, HLD, CKD, Dementia, AAA repair by EVAR	III
5	78	Male			HTN, CKD, Ex-tobacco use, AAA repair by EVAR	III

AAA – Aortic abdominal aneurysm; AFl – Auricular flutter; ASA – American Society of Anesthesiologists; CKD – Chronic kidney disease; DM – Diabetes Mellitus; EVAR – Endovascular aneurysm repair; HLD – Hyperlipidemia; HTN – Arterial hypertension; PPM – Permanent pacemaker; rAAA – Ruptured aortic abdominal aneurysm.

Table 2 **Operative characteristics**

Case	Case duration (min)	Estimated blood loss (ml)	Intraoperative blood transfusion	Hemodynamic instability (requiring vasopressor)
1	270	500	Yes	No
2	240	400	Yes	No
3	180	500	No	No
4	180	300	No	No
5	210	500	Yes	Yes

Table 3 **The outcome of the study cohort**

Case	Access site complication	Blood transfusion (Postoperative)	AKI	PIS	ICU LOS (Days)	Hospital LOS (Days)	30 Days M	1 Year M	2 Year M
1	No	Yes	No	No	4	12	No	No	Yes
2	No	No	No	Yes	6	8	No	No	No
3	Yes	No	No	No	3	7	Yes	Yes	Yes
4	No	No	No	No	6	8	No	No	No
5	Yes	Yes	Yes	No	4	9	No	No	No

AKI – Acute kidney injury; ICU – Intensive Care Unit; LOS – Length of stay; M – Mortality; PIS – Postimplantation syndrome.

surgery procedure start, to avoid infection.

Patient were placed in a supine position with both arms running parallel to the long axis of the abdomen.

The procedure was performed in the vascular operating room (OR) with imaging reconstruction capacity. The team comprised a vascular and a cardiac surgeon, a cardiovascular anesthesiologist, nursing staff, a radiology technician, and industry representatives. A cardiologist was present in the first two cases to place transvenous pacing wire and assisted rapid pacing during main graft deployment. In the latest cases, cardiac surgeon placed transvenous pacing and the cardiovascular anesthesiologist assisted in rapid pacing. All procedures were performed by the same operators and cardiovascular anesthesiologist.

Each patient received an initial dose of 100 mg/Kg heparin with a goal of activated clotting time (ACT) above 250s. ACT was repeated to heparin dosage adjustment (to maintain ACT above 250s). In the end of the procedure and according to

ACT, heparin was partially reverted with protamine. Arterial blood gas samples were also performed on an hourly basis.

The RELAY™ Branched Thoracic stent-graft systems (Terumo Aortic®), custom made, double branched endograft were retrograde delivered through percutaneous femoral access and deployed under rapid right ventricular pacing (180-220bpm). Afterwards, the two supra-aortic vessels were sequentially accessed via wire through bilateral cervical incisions.

All patients were extubated in the OR and the neurologic evaluation performed, being posteriorly transferred to the intensive care unit (ICU) for postoperative monitoring.

Operative characteristics are presented in Table 2.

Procedural technical success, defined as successful deployment and implantation of the aortic arch endograft with all target branch vessel stents deployed and patent at the time of the completion angiography, was achieved in all cases[3].

Regarding postoperative complications, early (occurring from day 2 to day 30 after surgery) and late complications (occurring after day 31 after surgery) were considered. The former included access site complications, blood transfusion, stroke, transient ischemic attack, myocardial infarction, paraplegia or other manifestation of spinal cord injury, acute kidney injury (AKI) – according to RIFLE criteria, aneurysm rupture, postimplantation syndrome (PIS); the later included endoleak, aneurysm rupture, device migration and graft infection.

Four patients developed early postoperative complications (Table 3). Access site complications were: hematomas in cervical and femoral region (n=1) and a left femoral false aneurysm due to malfunction of the percutaneous closure device (n=1), all with no need for surgical correction. Two patients received blood transfusion in the postoperative period. One patient developed AKI and one patient developed PIS.

No in-hospital death occurred. Two patients died during the follow-up period (median follow-up time 1.5 year). Causes of death were non-aorta-related in both cases.

No other complications were described during the follow-up period and no patient required secondary intervention.

Table 3 shows details of postoperative complications and outcomes.

DISCUSSION

TEAAR is a new surgical technique that our center has begun to implement. This complex procedure requires a skilled Aorta Team that facilitates appropriate patient selection for the surgery tailoring the best treatment for each individual, jointly plan staged procedures, improve optimisation before treatment, understands the procedural steps and their anesthetic implications and is experienced in the full spectrum of perioperative management of patients undergoing both endovascular and open procedures. A close relationship with the ICU to maximize postoperative care is also fundamental to optimize patient outcomes.

Invasive arterial blood pressure monitoring (placed in the right radial artery due to previous left subclavian bypass performed), bilateral bispectral index and cerebral oximetry are essential throughout the procedure.

The importance of bilateral bispectral index and cerebral oximetry is related to the high risk of embolic stroke, as these monitors are able to indicate significant changes in cerebral blood flow and detect hemispheric differences.

In the context of TEAAR, TEE monitoring is particular relevant to detect possible retrograde dissection, valve injury or tamponade after main graft deployment. It is important to note that the role of TEE is limited by suboptimal visualization of the origin of supra-aortic branches and the interposition of the left bronchus. Moreover, TEE probe should be pulled back as needed to not interfere with the arch stents fluoroscopy.

Noteworthy, vascular access through both common carotid arteries increases the risk of potential cervical hematomas and the severity of potential complications related to vascular access.

In our case series, we achieved a 100% successful deployment of arch endografts.

The follow-up shows patency of target vessels and no case of reintervention or endoleaks. The relatively short follow-up and small sample size may contribute to the low rate of complication events. Good patient selection, technical execution, anesthetic choices, and perioperative care are also determinants of favorable outcomes.

Our study, a retrospective, single-center case series, has limitations. All procedures were performed by the same two operators on selected patients. The outcomes should be generalized with caution as they may not be reproducible. Further studies with larger cohorts and longer follow-up periods are needed to solidify the evidence on TEAAR and the perioperative anesthetic management adopted. As TEAAR becomes more common, understanding its anesthetic implications and potential complications is crucial.

Considering our previous experience with endovascular thoracoabdominal aortic surgery, we presented the anesthetic management of patients who underwent TEAAR that showed positive outcomes facilitated by a thorough understanding of the procedure and close attention to hemodynamic stability.

REFERENCES

1. Jubouri M, Al-Tawil M, Tan SZCP, Geragotellis A, Hussain M, Bashir M, et al. Total endovascular aortic arch repair: is it for everyone and where is its evidence? Vessel Plus. 2023; 7(5). doi:10.20517/2574-1209.2022.49.
2. Tenorio, E, Macedo, T, Ocasio, L. et al. Total Transfemoral Percutaneous Endovascular Aortic Arch Repair Using 3-Vessel Inner Branch Stent-Graft. J Am Coll Cardiol Case Rep. 2022; 4(24). doi:10.1016/j.jaccas.2022.10.012.
3. Lee KB, Porras-Colon J, Scott CK, Chamseddin K, Baig MS, Timaran CH. Early Results and Feasibility of Total Endovascular Aortic Arch Repair Using 3-Vessel Company-Manufactured and Physician-Modified Stent-Grafts. J Endovasc Ther. 2023;28. doi: 10.1177/15266028231163069.