Arch Pathology: Surgery Is The Gold Standard
Introduction

• Replacing the aortic arch can be one of the most daunting procedures in surgery

• Procedures on the arch seem to go against almost everything we have learnt about cardiac surgery

• The demanding task of aortic arch surgery is not something that early pioneers could have envisaged....
Introduction

• Yet, we have risen to overcome these and refine this procedure to its contemporary form.

• Complex arch replacement is now a standard practice in specialized centers, with acceptable survival and complication rates, as well as reasonable patient satisfaction and quality of life.
Cerebral Protection

• The optimal selection of cerebral protection strategies is of critical in aortic arch surgery.

• A fundamental component of this has been deep hypothermic circulatory arrest (DHCA), which has been supplemented by retrograde cerebral perfusion (RCP) and then selective antegrade cerebral perfusion (SACP)
Hypothermia in Aortic Arch Surgery

<table>
<thead>
<tr>
<th>Category</th>
<th>Nasopharyngeal temperature</th>
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</thead>
<tbody>
<tr>
<td>Profound hypothermia</td>
<td>$\leq 14 , ^\circ C$</td>
</tr>
<tr>
<td>Deep hypothermia</td>
<td>14.1-20 $, ^\circ C$</td>
</tr>
<tr>
<td>Moderate hypothermia</td>
<td>20.1-28 $, ^\circ C$</td>
</tr>
<tr>
<td>Mild hypothermia</td>
<td>28.1-34 $, ^\circ C$</td>
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</table>
The graph illustrates the relationship between esophageal temperature and cerebral metabolic rate, expressed as a percentage of baseline. The x-axis represents esophageal temperature in °C, ranging from 5°C to 40°C, while the y-axis shows cerebral metabolic rate (% of baseline) from 0% to 100%. The graph is divided into four sections labeled Profound, Deep, Moderate, and Mild, each with a different trend line. The estimated safe duration of HCA (hypothermic circulatory arrest) is indicated on the right side of the graph, with times ranging from 0 minutes to 50 minutes. The blue line represents Profound hypothermia, starting at 100% and decreasing to 0% at 40°C. The red line represents Deep hypothermia, starting at 0% and increasing to 100% at 40°C. The Moderate hypothermia line is not shown, but it is inferred to be between the Profound and Deep hypothermia lines. The Mild hypothermia line is also not shown, but it is assumed to follow a similar trend as the Deep hypothermia line, starting at 100% and decreasing as the temperature increases.
Open aortic arch reconstruction

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A retrospective analysis of data from all patients admitted to the University of Michigan Hospitals from 1993 to 2009 who underwent aortic arch replacement via a median sternotomy was performed (n=721). Details of the operative technique have been described in our previous work (5).
Early mortality was seen in 36 patients (5.0%). By multivariate analysis, older age, lower ejection, prolonged cardiopulmonary bypass and hypothermic circulatory arrest time were independently associated with early mortality.
Stroke was identified in 34 patients (4.7%).
By multivariate analysis, independent predictors of stroke included history of COPD, procedure for type A dissection, prolonged HCA time, resection into proximal descending aorta and occurrence of permanent postoperative dialysis.
Open Aortic Arch Repair

• In high-volume centers and in patients at low risk, surgical techniques such as complete open repair of the aortic arch or the hybrid (frozen) elephant trunk have been associated with a mortality rate of up to 9% and a stroke rate of 4% to 12%

• However, conventional surgical techniques for managing the aortic arch are invasive and frequently associated with a significant systemic inflammatory response syndrome and related complications.
Reoperative cardiac surgery is a higher risk of both morbidity and mortality, and this fact holds true for reoperative aortic surgery.

Aortic surgery following a prior sternotomy for cardiac surgery with an in-hospital mortality rate of 11.5%

Low stroke rate at 3.3% despite nearly 21% of patients having experienced a preoperative CVA
Endovascular Aortic Arch Repair
• Over the past 10 years, thoracic endovascular aneurysm repair (TEVAR) has prevailed as the treatment of choice for pathologies of the descending aorta and aortic arch up to zone 2.

• The superiority of TEVAR in comparison to open repair in reducing perioperative and long-term severe morbidity has been demonstrated in a prospective comparative study.
Endovascular Aortic Arch Repair

- ENDOVASCULAR HYBRID TECHNIQUES
- CHIMNEY PROCEDURES
- IN SITU FENESTRATED AORTIC ARCH ENDOGRAFTS
- CUSTOM-MADE FENESTRATED AND BRANCHED STENT GRAFTS
Technical Challenges of Endovascular Aortic Arch Repair

• The special hemodynamic and anatomic characteristics of the aortic arch make manipulation in this region challenging.

• The supra-aortic branches perfuse the brain, which has a low ischemic tolerance.

• Inaccuracy of stent graft placement can have fatal consequences for the patient and increase the risk of endoleaks and stroke.
Technical Challenges of Endovascular Aortic Arch Repair

- Aortic arch is wide, angulated, pulsatile, and is further away from the typical access vessels, the femoral arteries.
- Presence of plaque and thrombus in the aortic arch (ie, “shaggy aorta”) increases the risk for brain embolism
Conclusion

• Today, open surgery is considered the gold standard in treating the ascending aorta and the aortic arch.

• Hybrid interventions can be a good alternative to open surgery in high-risk patients.

• The future of fenestrated and branched TEVAR in the aortic arch is promising and represents a potential future option for more patients with aortic arch disease.