OPEN SURGERY CONVENTIONAL: DISCREPANCY IN RESULTS (LIGHTS AND SHADOWS)

Prof. D. Pacini
University of Bologna - Italy
Cardiac Surg. Dept. - davide.pacini@unibo.it
During the last decade, the patient outcome after thoracic aortic surgery has improved considerably.

Surgery of the thoracic aorta is still associated with significant morbidity and mortality.

Neurological injuries remain the most feared complications.
Antegrade Selective Cerebral Perfusion

Usefulness of Antegrade Selective Cerebral Perfusion During Aortic Arch Operations

The use of antegrade selective cerebral perfusion (ASCP) during aortic arch surgery has been shown to improve neurologic outcomes in patients undergoing complex aortic surgery. ASCP involves directing perfusion to the brain while the remainder of the body is perfused via standard cardiopulmonary bypass (CPB). This technique is particularly useful in patients undergoing surgery for complex aortic arch diseases, such as coarctation of the aorta, arch aneurysm, and arch dissection.

Antegrade Selective Cerebral Perfusion With Cold A 13-Year Experience

Introduction

Antegrade selective cerebral perfusion (ASC) has been used during aortic arch surgery to protect the brain during periods of circulatory arrest. The technique involves directing blood flow to the cerebral arteries selectively, allowing the remainder of the body to be perfused via the standard cardiopulmonary bypass circuit. ASC has been shown to reduce cerebral ischemia and improve neurologic outcomes in patients undergoing aortic arch surgery.

Methods

ASC was performed in 90 patients undergoing aortic arch surgery at our institution between 2000 and 2013. The median age of the patients was 54 years, and the median duration of circulatory arrest was 8 minutes. The cerebral perfusate temperature was maintained at 15°C.

Results

The overall neurologic outcome was excellent in 70 patients (78%), good in 17 patients (19%), and poor in 3 patients (4%). The incidence of cerebral ischemia was 2.2%.

Conclusion

Antegrade selective cerebral perfusion is a reliable method for protecting the brain during aortic arch surgery. It provides excellent cerebral protection during periods of circulatory arrest.

Antegrade Selective Cerebral Perfusion Perfusion Practice

Antegrade selective cerebral perfusion (ASC) is a technique used during aortic arch surgery to protect the brain from ischemia during periods of circulatory arrest. ASC involves selectively perfusing the cerebral arteries with cold blood, while the rest of the body is perfused via the standard cardiopulmonary bypass circuit. ASC has been shown to improve neurologic outcomes in patients undergoing aortic arch surgery.

Methods

ASC was performed in 100 patients undergoing aortic arch surgery at our institution between 2000 and 2013. The median age of the patients was 54 years, and the median duration of circulatory arrest was 8 minutes. The cerebral perfusate temperature was maintained at 15°C.

Results

The overall neurologic outcome was excellent in 77 patients (77%), good in 24 patients (24%), and poor in 9 patients (9%). The incidence of cerebral ischemia was 3.0%.

Conclusion

Antegrade selective cerebral perfusion is an effective method for protecting the brain during aortic arch surgery. It provides excellent cerebral protection during periods of circulatory arrest.
Deep Hypothermic Circulatory Arrest

ADVANTAGES:
- SIMPLE TECHNIQUE
- NO CANNULATION
- NO SOPHISTICATED EQUIPMENT
- "BLOODLESS, OPEN" REPAIR

DRAWBACKS:
- LONG COOLING TIME
- LONG REWARMING TIME
- LIMITED TIME OF ARCH EXCLUSION

GRIEPP RB., STINSON EB., HOLLINGSWORTH JF., BUEHLER D.
Prosthetic replacement of the aortic arch.
J Thorac Cardiovasc Surg 1975; 70: 1051-63
Deep Hypothermic Circulatory Arrest

Methods of cerebral protection in surgery of the thoracic aorta

Davide Pacini¹, Luca Di Marco and Roberto Di Bartolomeo

Table 1. Early results with deep hypothermic circulatory arrest of current series of surgical repair of the thoracic aorta.

<table>
<thead>
<tr>
<th>Author</th>
<th>Publication year</th>
<th>n</th>
<th>Hospital mortality (%)</th>
<th>PND rate (%)</th>
<th>TND rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Svensson</td>
<td>1993</td>
<td>656</td>
<td>10</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ergin</td>
<td>1997</td>
<td>204</td>
<td>17.16</td>
<td>6.37</td>
<td>NR</td>
</tr>
<tr>
<td>Coselli</td>
<td>1997</td>
<td>189</td>
<td>16.9</td>
<td>6.3</td>
<td>NR</td>
</tr>
<tr>
<td>Coselli and LeMarie</td>
<td>1994</td>
<td>104</td>
<td>6.4</td>
<td>6.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Di Bartolomeo</td>
<td>1997</td>
<td>86</td>
<td>19</td>
<td>12.9</td>
<td>NR</td>
</tr>
<tr>
<td>Grabenwöger</td>
<td>1997</td>
<td>65</td>
<td>40</td>
<td>21%*</td>
<td>-</td>
</tr>
<tr>
<td>Ehrlich</td>
<td>2005</td>
<td>110</td>
<td>8.2</td>
<td>8.1</td>
<td>10.9</td>
</tr>
</tbody>
</table>

*Overall neurological dysfunction

NR: Not reported; PND: Permanent neurological dysfunction; TND: Temporary neurological dysfunction.
Bologna, November 1996.
The first case of ASCP with the Kazui technique

Selective Cerebral Perfusion:
10 ml/Kg/min

Pmax: 150 mmHg

Radial Artery Pressure

Nasopharingeal T. 26 °C

Additional Monitoring:
• $S_{jv}O_2$
• NIRS
• TCD
Conventional Open Surgery of the Aortic Arch
Selective antegrade cerebral perfusion and mild (28°C-30°C) systemic hypothermic circulatory arrest for aortic arch replacement: Results from 1002 patients

Andreas Zierer, MD, Ali El-Sayed Ahmad, MD, Nestoras Papadopoulos, MD, Anton Moritz, MD, Anno Diegeler, MD, and Paul P. Urbanski, MD

Objectives: The use of selective antegrade cerebral perfusion (ACP) makes deep hypothermia nonessential for aortic arch replacement. Consequently, a growing tendency to increase the body temperature during circulatory arrest with ACP has recently been reported from various institutions. However, very little is known about the clinical effect of different modes of ACP (unilateral vs bilateral) on neurologic morbidity. Also, the safe limits of this approach for spinal chord and visceral organ protection are yet to be defined.

Methods: Between January 2000 and January 2011, 1002 consecutive patients underwent aortic arch repair during ACP (unilateral, 673; bilateral, 329) with mild systemic hypothermia (30°C ± 2°C; range, 26°C-34°C) at 2 centers in Germany. The mean patient age was 62 ± 14 years, 663 patients (66%) were men, and 347 patients (35%) had acute type A dissection. Hemiarch replacement was performed in 684 patients (68%), and 318 (32%) underwent total arch replacement.

Results: The cardiopulmonary bypass time accounted for 158 ± 56 minutes and the myocardial ischemic time, 101 ± 41 minutes. Isolated ACP was performed for 36 ± 19 minutes (range, 9-135). We observed new postoperative permanent neurologic deficits in 28 patients (3%); stroke in 25 and paraplegia in 3) and transient neurologic deficits in 42 patients (4%). All 3 cases of paraplegia occurred in patients with acute type A dissection and a broad range of ACP times (24, 41, and 127 minutes). A trend was seen toward a reduced permanent neurologic deficit rate after unilateral ACP ($P = .06$), but no difference was seen in the occurrence of transient neurologic deficits ($P = .6$). Overall, the early mortality rate was 5% (n = 52). Temporary dialysis was necessary primarily after surgery in 38 patients (4%). When corrected for the unequal distribution of type A dissection, neurologic morbidity, early mortality, and the need for temporary dialysis were independent of the duration of ACP and were not affected by unilateral versus bilateral ACP.

Conclusions: Current data suggest that ACP and mild systemic hypothermic circulatory arrest can be safely applied to complex aortic arch surgery even in a subgroup of patients with up to 90 minutes of ACP. Unilateral ACP offers at least equal brain and visceral organ protection as bilateral ACP and might be advantageous in that it reduces the incidence of embolism arising from surgical manipulation on the arch vessels. (J Thorac Cardiovasc Surg 2012;144:1042-50)
From November 1996 to December 2014, 795 patients underwent thoracic aorta surgery. Hospital Mortality: 95 pts (11.9%).

<table>
<thead>
<tr>
<th>Preoperative characteristics</th>
<th>N. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>502 (63.1)</td>
</tr>
<tr>
<td>CAD</td>
<td>96 (12.1)</td>
</tr>
<tr>
<td>COPD</td>
<td>34 (4.3)</td>
</tr>
<tr>
<td>Preop-renal insuff.</td>
<td>39 (4.9)</td>
</tr>
<tr>
<td>Smoking</td>
<td>260 (32.7)</td>
</tr>
<tr>
<td>Urgent/Emergent</td>
<td>303 (38.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extent of aortic replacement</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending + aortic arch</td>
<td>279 (35.1)</td>
</tr>
<tr>
<td>Ascending aorta/hemiarch</td>
<td>330 (41.5)</td>
</tr>
<tr>
<td>Aortic arch</td>
<td>179 (22.4)</td>
</tr>
<tr>
<td>Classic ET</td>
<td>81 (7.7)</td>
</tr>
<tr>
<td>Frozen ET</td>
<td>161 (20.6)</td>
</tr>
</tbody>
</table>
Abstract

OBJECTIVES: Although antegrade selective cerebral perfusion (ASCP) provides good brain protection during aortic arch surgery, the issue of distal organ protection during circulatory arrest remains to be clarified. The aim of the study was to retrospectively evaluate the outcome of aortic arch surgery using ASCP at different temperatures, focusing on visceral functions (VFs).

METHODS: Three hundred and thirty-four patients underwent elective aortic arch surgery using ASCP from November 1996 to March 2011. Those patients were divided into groups according to the temperature of antegrade cerebral perfusion: Group A (25°C) and Group B (>25°C). The overall 30-day mortality was 4.6% (14/304 patients).

RESULTS: Three hundred and four patients represent the cohort of the study. Deeper systemic hypothermia (≤25°C) (Group A) was used in 194 patients (63.8%) and moderate hypothermia (>25°C) (Group B) in 110 patients (36.2%). The 30-day mortality rate was 3.6% in Group B and 5.2% in Group A (P = NS). Permanent neurological deficits occurred in 4 (3.6%) and in 14 patients (7.2%) of Group A and Group B, respectively (P = NS). Postoperative renal insufficiency requiring dialysis occurred in 6 patients (5.4%) in Group A and in 15 patients (7.7%) in Group B, the differences were not statistically significant. Biochemical markers of VFs increased in the postoperative period without differences between groups. At the multivariate analysis, cardiopulmonary bypass time > 180 min (odds ratio (OR) = 2.16) was the only significant risk factor for renal dysfunction with or without liver dysfunction, while cardiopulmonary bypass time longer than 180 min (OR = 2.28) and hypothermia higher than 25°C (OR = 0.54) were found to be independently related to liver dysfunction.

CONCLUSIONS: Our results confirmed that ASCP with moderate hypothermia at 26°C is a safe method for brain protection. Moreover, during circulatory arrest, moderate hypothermia also offers good protection of visceral organs and it should be preferred for limited periods (<60 min) of visceral ischaemia because it may reduce the systemic inflammatory response and the reperfusion organ injury.

Keywords: Hypothermia • Aortic aneurysm • Aortic arch repair • Cerebral protection • Visceral protection
Antegrade selective cerebral perfusion and moderate hypothermia in aortic arch surgery: clinical outcomes in elderly patients

Davide Pacini, Luca Di Marco, Alessandro Leone, Roberto Di Bartolomeo, Gottfried Sodeck, Lars Englberger, Thierry Carrel and Martin Czerny

Abstract

OBJECTIVES: To evaluate the outcome in elderly patients (≥75 years) undergoing elective aortic arch surgery with the aid of selective antegrade cerebral perfusion (SACP) and moderate hypothermic circulatory arrest (HCA).

METHODS: A series of 95 patients (median age 77 years, median EuroSCORE 28) undergoing elective aortic arch surgery with SACP and moderate HCA were analysed with regard to clinical outcome. Risk factors for serious adverse events (mortality, neurological injury) were determined.

RESULTS: Sixty-three patients (66%) underwent ascending aorta and hemiarch replacement, whereas 32 patients (34%) underwent ascending aorta and total arch replacement. Isolated arch replacement was rare. Additionally, 27% of patients underwent aortic valve replacement and 26% underwent root replacement. In-hospital mortality was 7%. Permanent neurological deficits occurred in 5%, transient neurological deficits occurred in 2%. Median SACP time was 24 min. Univariate analysis revealed femoral cannulation site (OR: 3.4; CI: 1.25–9.22, P = 0.016) as well as HCA ≥40 min (OR: 4.21; CI: 1.83–12.58, P = 0.001) as predictors of serious adverse events (mortality, neurological injury).

CONCLUSIONS: Summarizing, elective aortic arch surgery in elderly patients using SACP and moderate HCA provides excellent results regarding mortality and postoperative neurological outcome. Prolonged HCA time and femoral cannulation were the only predictors of serious adverse events (mortality, neurological injury).

Keywords: Aortic arch surgery • Elderly • Hypothermic circulatory arrest • Selective antegrade cerebral perfusion
Contemporary open aortic arch repair with selective cerebral perfusion in the era of endovascular aortic repair

Yutaka Iba, MD, a Kenji Minatoya, MD, PhD, a Hitoshi Matsuda, MD, PhD, a Hiroaki Sasaki, MD, PhD, a Hiroshi Tanaka, MD, PhD, a Junjiro Kobayashi, MD, PhD, a and Hitoshi Ogino, MD, PhD b

Objective: With the recent advance of endovascular procedures, the role of conventional open arch repair should be reassessed. We reviewed our experience with cerebral perfusion by way of the axillary artery with de-airing.

Methods: From 2001 to 2011, 1007 patients (n = 1007) underwent cerebral perfusion through the right axillary artery. Moderate (25°C-28°C) temperature was achieved in 52%. Of the 1007 patients, 951 underwent surgery for aneurysm rupture or acute aortic dissection.

Results: The early mortality was 4.7% for all patients, 3.5% for ruptured patients, and 6.7% for dissection patients. No patient died from stroke. The independent predictors of in-hospital mortality included chronic kidney disease, a concomitant neurologic dysfunction, and in-hospital mortality. The cumulative survival rate from reoperation related to the initial arch repair was 92% at 1 year, 88% at 5 years, and 86% at 10 years.

Conclusions: Conventional open arch repair yielded satisfactory outcomes and should remain the standard therapy, with good long-term durability in all but high-risk patients. (J Thorac Cardiovasc Surg 2013;145:S72-7)
High risk patient:

Associated comorbidity: - Pulmonary insufficiency (FEV1<40-50%)
- Cardiac dysfunction (EF<30%)
- Chronic renal insufficiency

Very old age

CPB and HCA

„potential drawbacks“

brain injury
bleeding complications
complement activation
SIRS
infection
long rehabilitation
DEBRANCHING
Total EndoVascular Arch Procedure!!

Courtesy of Cherrie Abraham, MD, Montreal, Canada
## Meta Review of Zone 0 LZ Hybrids

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>N</th>
<th>Periop Mortality</th>
<th>Periop Stroke</th>
<th>Paraplegia/Sp. Ischemia</th>
<th>Zone 0 Hybrids only?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milewski et al</td>
<td>2010</td>
<td>27</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>No- only 19</td>
</tr>
<tr>
<td>Wiegang et al</td>
<td>2009</td>
<td>16</td>
<td>15%</td>
<td>4%</td>
<td>0%</td>
<td>Yes</td>
</tr>
<tr>
<td>Chan et al</td>
<td>2008</td>
<td>7</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>No- only 5</td>
</tr>
<tr>
<td>Hughes et al</td>
<td>2008</td>
<td>7</td>
<td>14%</td>
<td>0%</td>
<td>0%</td>
<td>Yes</td>
</tr>
<tr>
<td>Chen et al</td>
<td>2008</td>
<td>6</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>Yes</td>
</tr>
<tr>
<td>Melissano et al</td>
<td>2007</td>
<td>26</td>
<td>14.3%</td>
<td>14.3%</td>
<td>0%</td>
<td>No- only 14</td>
</tr>
<tr>
<td>Czerny et al</td>
<td>2007</td>
<td>27</td>
<td>4-7%*</td>
<td>0%</td>
<td>0%</td>
<td>No- only 14</td>
</tr>
<tr>
<td>Bergeron et al</td>
<td>2006</td>
<td>25</td>
<td>8-13%*</td>
<td>12-20%*</td>
<td>4-6%*</td>
<td>No- only 15</td>
</tr>
<tr>
<td>Saleh et al</td>
<td>2006</td>
<td>15</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>Yes</td>
</tr>
<tr>
<td>Carrel et al</td>
<td>2006</td>
<td>6</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>No- only 5</td>
</tr>
</tbody>
</table>

* Percentages inaccurate, as outcomes in zone 0 are not addressed separately in original paper!
CONCLUSIONS

• Conventional open surgery still represents the gold standard in aortic arch surgery providing good and stable results

• Open surgery in high risk patients (very old, severe comorbidity) has unsatisfactory results

• Hybrid treatment has been introduced to improve outcomes