

# Improved Outcomes of Total Arch Replacement: Does Cerebral Perfusion Strategy Matter?

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# BACKGROUND AND OBJECTIVES

- Total arch replacement is a complex aortic procedure with significant early morbidity and mortality
- Review our institutional experience of total arch replacement (TAR)
- Analyze the short-term and long-term outcomes of TAR

# METHODS

- Study period - From 1/1993 through 6/2023
- Retrospective analysis of all adult patients (n=334) undergoing TAR
- Median age 64.8 years (IQR, 55.6-73.4), males, n=214, 64.1%
- Marfan syndrome, n= 36 (10.8%), Bicuspid aortic valve, n=47 (14.1%)
- Hypertension, n= 278 (83.5%), Stroke, n= 44 (13.3%)
- Redo surgery, n= 204 (61.1%)

# RESULTS – INDICATIONS

| <b>Patients undergoing primary sternotomy</b>        | <b>N (%)</b> |
|--|--------------|
| Aneurysmal degeneration                              | 120 (92.3%)  |
| Type A dissection                                    | 78 (23.3%)   |
| Chronic type B dissection                            | 6 (4.6 %)    |
| Arch transection from blunt trauma                   | 2 (1.5%)     |
| Penetrating ulcer, arch                              | 1 (0.8%)     |
| <b>Patients undergoing repeat sternotomy</b>         | <b>N (%)</b> |
| Dissecting aneurysm                                  | 97 (51.5%)   |
| Aneurysm   | 70 (37.2%)   |
| Arch dissection                                      | 10 (5.3%)    |
| Dehiscence of distal anastomosis / contained rupture | 8 (4.2%)     |
| Pseudoaneurysm                                       | 3 (1.6%)     |

# RESULTS – OPERATIVE DATA

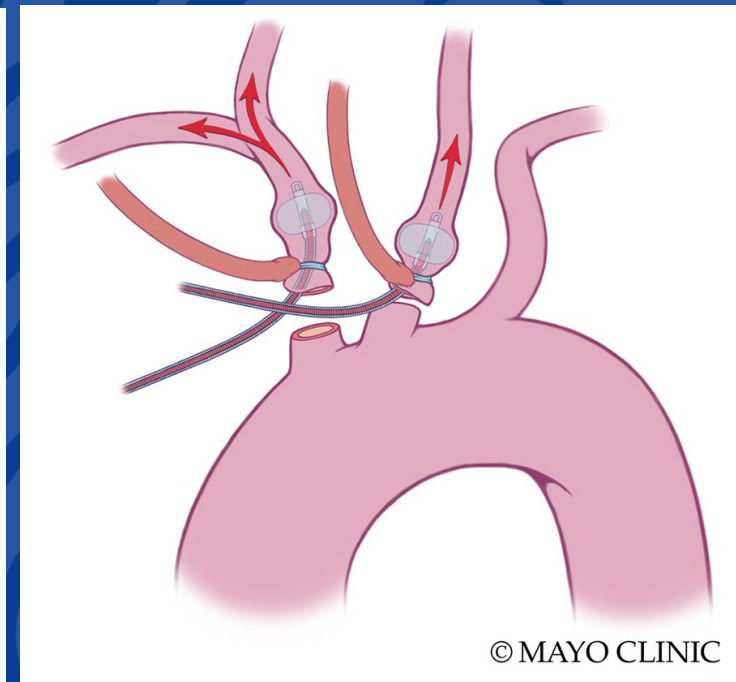
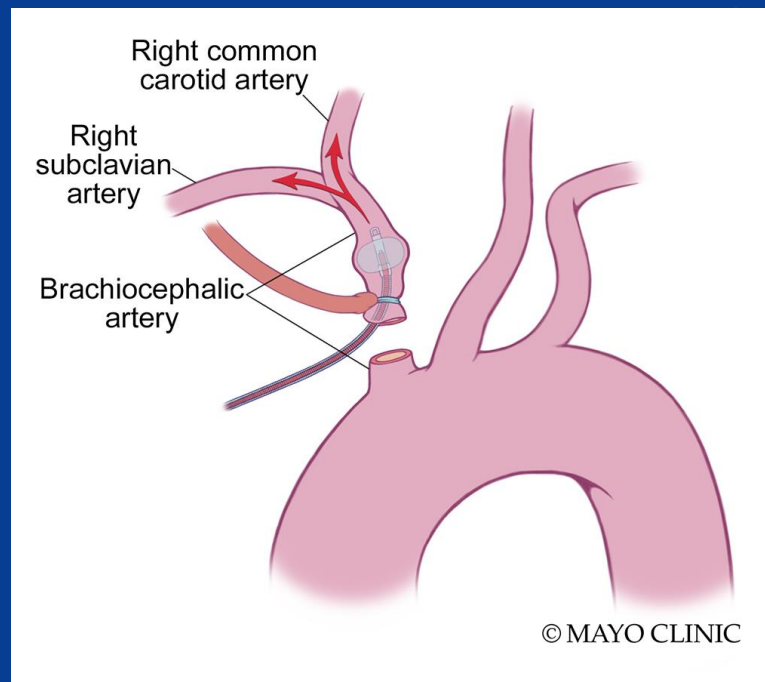
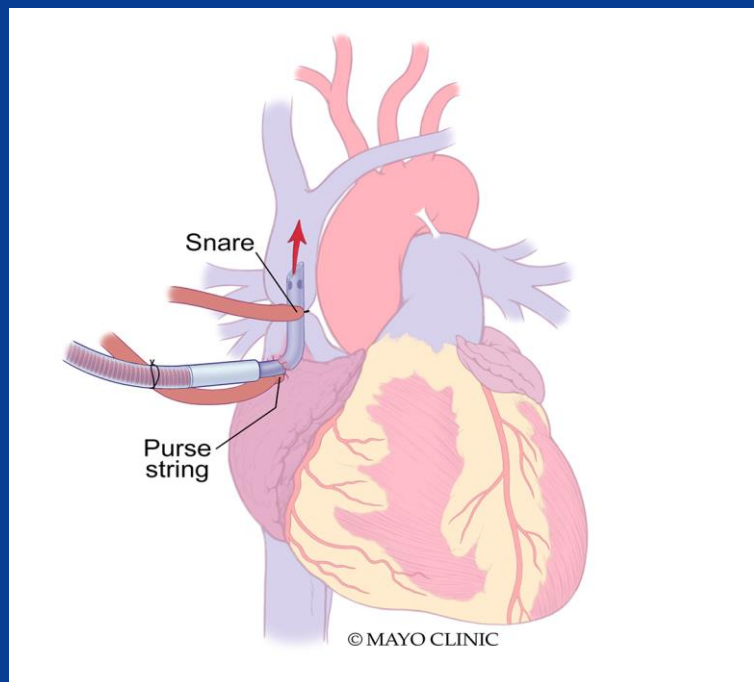
| Procedure   | N (%)                |
|---|----------------------|
| TAR + Frozen elephant trunk                                   | 118 (35.2%)          |
| TAR + Classic elephant trunk                                  | 116 (34.7%)          |
| TAR + Ascending aorta replacement                             | 204 (61.1%)          |
| TAR + Aortic root replacement                                 | 88 (26.3%)           |
| TAR + Ascending aorta replacement + aortic valve resuspension | 73 (21.9%)           |
| TAR + Ascending aorta replacement + aortic valve replacement  | 111 (33.2%)          |
| Three head vessels reimplantation                             | 241 (72.2%)          |
| Two head vessels reimplantation                               | 77 (23.1%)           |
| Single head vessel reimplantation                             | 16 (4.8%)            |
| Cross-clamp time, minutes, median (Q1,Q3)                     | 183.0 (134.0, 238.0) |
| Cardiopulmonary bypass time, minutes, median (Q1,Q3)          | 275.0 (231.5, 317.0) |
| Circulatory arrest time, minutes, median (Q1,Q3)              | 47.0 (37.0, 60.0)    |

# RESULTS – CEREBRAL PROTECTION

| Cerebral protection methods                               | N (%)            |
|---|------------------|
| Deep hypothermia (14.1-20 °C) <sup>1</sup>                | 316 (94.6%)      |
| Moderate hypothermia (20.1-28 °C)                         | 18 (5.4%)        |
| Cerebral perfusion strategy                               |                  |
| Antegrade alone, unilateral                               | 27 (9.5%)        |
| Antegrade alone, bilateral                                | 59 (17.6%)       |
| Retrograde alone  | 15 (5.2%)        |
| Retrograde, then unilateral antegrade                     | 6 (2.1%)         |
| Retrograde, then bilateral antegrade                      | 177 (62.3%)      |
| Retrograde cerebral perfusion time, minutes, median,Q1,Q3 | 9.0 (6.0-11.0)   |
| Antegrade cerebral perfusion time, minutes, median,Q1,Q3  | 42.0 (33.0-54.0) |

<sup>1</sup>Yan et al. Consensus on hypothermia in aortic arch surgery. Ann Cardiothorac Surg. 2013 Mar;2(2):163-8.

# RESULTS – CEREBRAL PROTECTION



RCP time, min, median, Q1, Q3  
9.0  
(6.0-11.0)

ACP time, min, median, Q1, Q3  
42.0  
(33.0-54.0)

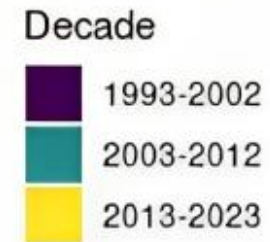
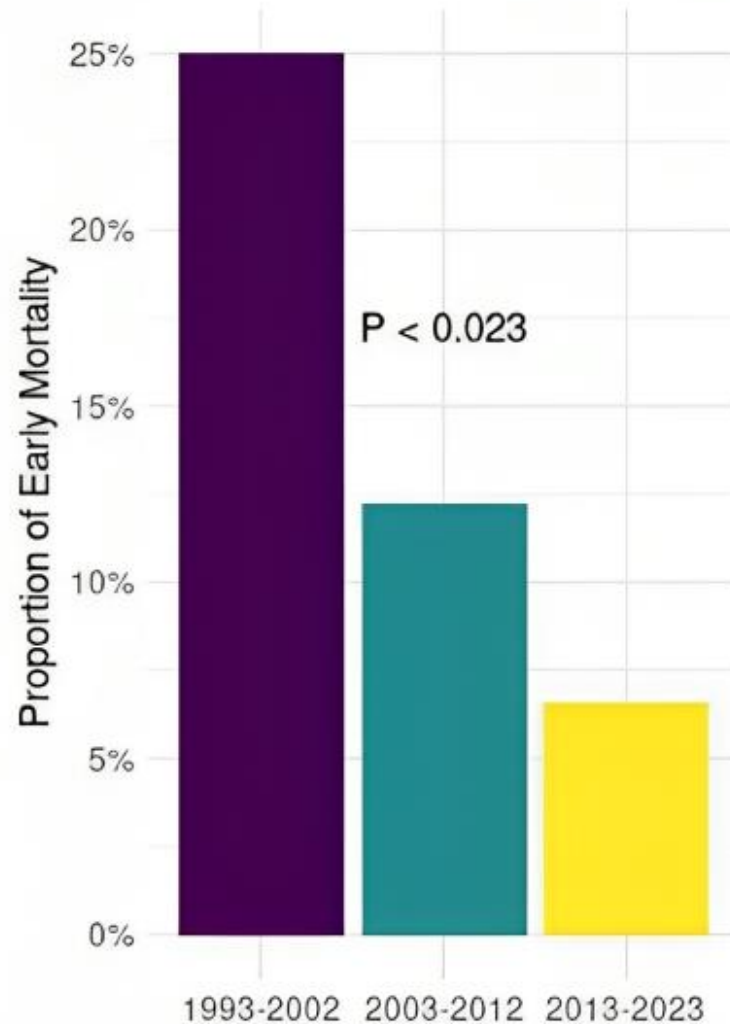
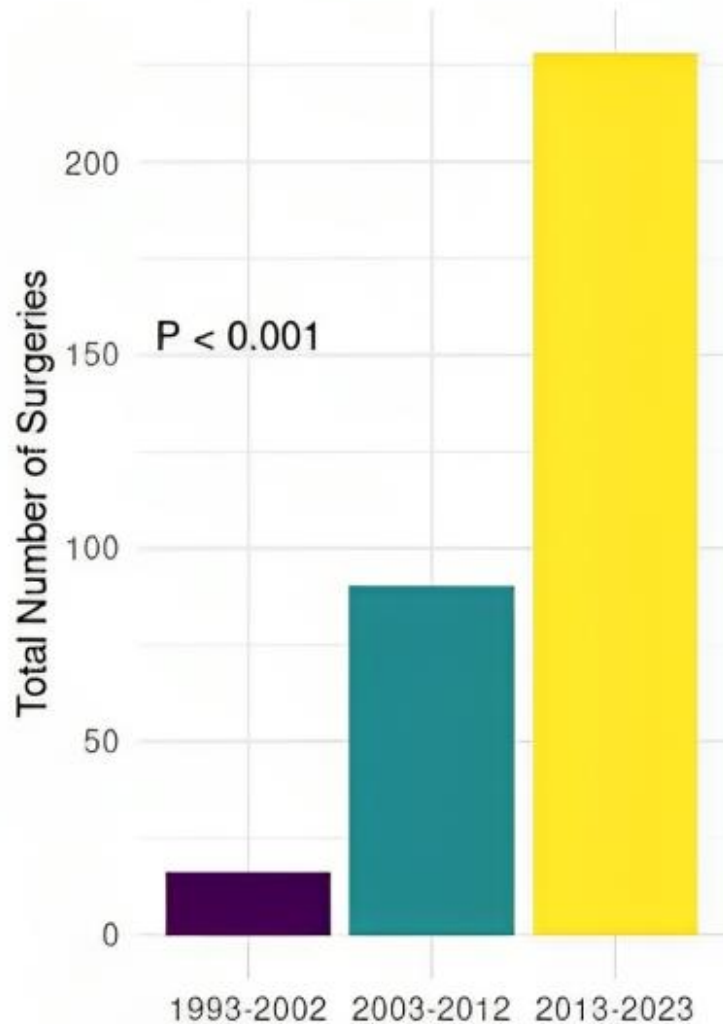
RCP time in combined RCP & ACP, min, median, Q1, Q3  
8.0 (6.0-10.0)

ACP time in combined RCP & ACP, min, median, Q1, Q3  
41.0 (33.8-49.2)

# RESULTS – EARLY

| Variables                                     | N (%)              |
|---|--------------------|
| Blood products                                | 196 (60.3%)        |
| Red blood cells, units, median,Q1,Q3          | 2.0 (1.0, 5.0)     |
| Fresh frozen plasma, units, median,Q1,Q3      | 2.0 (2.0, 4.5)     |
| Platelets, units, median,Q1,Q3                | 1.0 (1.0, 2.2)     |
| Cryoprecipitate, units, median,Q1,Q3          | 2.0 (2.0, 4.0)     |
| Prolonged ventilation                         | 54 (16.6%)         |
| Renal failure                                 | 27 (8.0%)          |
| Extra corporeal membrane oxygenation support  | 7 (2.0%)           |
| Intensive care unit stay, hours, median,Q1,Q3 | 65.9 (23.7, 116.8) |
| Length of hospital stay, days, median,Q1,Q3   | 9.0 (7.0, 13.0)    |
| Operative mortality                           | 30 (9.3%)          |





The number of patients undergoing TAR has increased ( $p < 0.001$ ) & early mortality decreased ( $p < 0.023$ ) with each successive decade

# UNIVARIATE ANALYSIS - EARLY MORTALITY

| Variables                              | Levels                   | OR (univariable)                      |
|--|--------------------------|---------------------------------------|
| Dissection extent into abdominal aorta | No                       | -                                     |
|  | Yes                      | 5.00 (0.95-21.98, <b>p=0.038</b> )    |
| Number of head vessel implantation     | 1                        | -                                     |
|  | 2                        | 0.25 (0.06-1.11, p=0.056)             |
|  | 3                        | 0.27 (0.09-1.04, <b>p=0.036</b> )     |
| Cerebral perfusion                     | Retrograde and antegrade | -                                     |
|  | Antegrade only           | 3.14 (1.27-7.99, <b>p=0.013</b> )     |
|  | Retrograde only          | 9.67 (2.59-34.04, <b>p&lt;0.001</b> ) |
|  | None                     | 1.68 (0.44-5.42, p=0.405)             |
| Year of surgery                        | 1993-2002                | -                                     |
|  | 2003-2012                | 0.42 (0.12-1.69, p=0.187)             |
|  | 2013-2023                | 0.21 (0.06-0.83, <b>p=0.015</b> )     |

# STROKE

- Postoperative stroke, n=11 (3.2%)
- Associated with peripheral vascular disease ( $p=0.029$ ) and repeat sternotomy (0.007)
- Not significantly associated with either cerebral perfusion methods or surgery year

# LATE OUTCOMES

- Median follow-up, 5.7 (IQR, 2.8-10.2) years
- Survival at 5 and 10 years was 71% (95%CI 66%-77%) and 54% (95%CI 47%-62%), respectively
- Older age was the only factor independently associated with poorer long-term survival (HR 1.05; 95%CI 1.03-1.06)
- Freedom from reoperation was 96% (95%CI 93%-99%) at 5 years and 92% (95%CI 86%-98%) at 10 years

# CONCLUSIONS

- Over the last three decades, our institutional experience in TAR has improved with increasing numbers and declining early mortality rates
- Most patients are undergoing TAR in the setting of repeat sternotomy
- Improved early results may relate to overall increase in institutional experience, dedicated team approach and a combined cerebral protection strategy
- Older age was the only factor independently associated with poorer long-term survival