Is axillary superior to femoral artery cannulation for acute type A aortic dissection surgery?

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Abstract

A best evidence topic was written according to a structured protocol. The question addressed was whether axillary artery cannulation (AXC) is superior to femoral artery cannulation (FAC) in patients undergoing surgical repair of acute type A aortic dissection. A total of 90 studies were identified using the reported search, of which 10 represented the best evidence to answer the clinical question. There were nine retrospective studies and one meta-analysis. The authors, date, journal, country, study type, population, outcomes and key results are tabulated. Four papers, including the meta-analysis, reported significantly increased mortality in patients undergoing surgery with FAC. From these, two papers, again including the meta-analysis, reported also significantly increased neurological dysfunction, and another one demonstrated significantly increased incidence of postoperative bleeding and sternal infections in this same group of patients. Two more studies reported decreased mortality, malperfusion and neurological complications in patients undergoing surgical repair with AXC, but no statistical analysis was performed. Three reports comparing AXC and FAC found no difference between the two groups in terms of operative mortality and major complications, while another one demonstrated increased incidence of postoperative mortality in patients undergoing surgery with AXC, most likely due to the presence of malperfusion of one or more organs preoperatively in those who died. AXC, however, needs to be stressed that, in three reports, the superiority of AXC over FAC might be attributed to the fact that patients in the latter group were critically ill in haemodynamic collapse. Nevertheless, this indicates that the femoral artery remains a bailout option in the emergency situation when institution of cardiopulmonary bypass is required rapidly.

Keywords: Acute type A aortic dissection • Femoral artery cannulation • Axillary artery cannulation • Postoperative complications • Mortality

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

THREE-PART QUESTION

In [patients submitted to acute type A aortic dissection surgical repair] is [axillary superior to femoral artery cannulation] in [terms of mortality and morbidity]?

CLINICAL SCENARIO

A 59-year old gentleman presents with acute type A aortic dissection. Imaging reveals that the dissection extends from the sinotubular junction to the descending thoracic aorta with involvement of the left common carotid and subclavian arteries. The patient needs emergency surgical repair. Options for institution of cardiopulmonary bypass (CPB) inflow include cannulation of the axillary (AXC) or femoral artery (FAC). You wonder whether antegrade flow with AXC offers improved outcomes compared with retrograde flow with FAC.

SEARCH STRATEGY

A systematic search was conducted of Medline (R) from 1946 to September 2014 using the Ovid interface. The search strategy employed: (exp Aneurysm, Dissecting/OR type A aortic dissection.mp) AND (exp Cardiopulmonary Bypass/OR cardiopulmonary bypass.mp) AND (exp Axillary Artery/OR axillary artery cannulation.mp OR exp Subclavian Artery/OR subclavian artery cannulation.mp OR exp Femoral Artery/OR femoral artery cannulation.mp).
SEARCH OUTCOMES

The search yielded 90 results. All relevant papers were screened and their reference lists were cross-checked. This process extracted 10 papers that were deemed to offer the best evidence. The papers are detailed in Table 1.

RESULTS

Ren et al. [2] performed a meta-analysis of nine retrospective studies with a total of 715 patients (AXC: n = 359 and FAC: n = 356). Patients undergoing AXC had significantly reduced operative mortality (OR = 0.25, 95% CI 0.15–0.42, \( \chi^2 = 7.23, P < 0.01 \)) and neurological dysfunction (OR = 0.46, 95% CI 0.29–0.72, \( \chi^2 = 9.01, P < 0.01 \)) compared with those having FAC. The superior neurological outcomes in the first group might be due to the use of antegrade cerebral perfusion and avoidance of retrograde embolization by atherosclerotic debris and use of moderate as opposed to deep hypothermic circulatory arrest with FAC. The difference in the incidence of malperfusion did not reach statistical significance between the two groups (OR = 0.84, 95% CI 0.37–1.90, \( \chi^2 = 2.25, P = 0.67 \)).

Nouraei et al. [3] retrospectively reviewed 49 patients undergoing ascending aortic repair (with or without aortic arch replacement) for acute type A aortic dissection. Institution of CPB was performed through the subclavian artery in 20 patients (41%; AXC) and through the femoral artery in 29 patients (59%). The authors reported a postoperative mortality rate of 10% in the AXC group and 44% in the FAC group. FAXC was found to be a significant predictor of hospital death (RR = 1.6, 95% CI 1.1–2.3, \( P = 0.02 \)), postoperative neurological deficit (RR = 4.0, 95% CI 1.1–15.0, \( P = 0.02 \)) and need for reoperation (OR = 1.7, 95% CI 1.08–2.8, \( P < 0.05 \)).

Moizumi et al. [4] reported on 106 patients with acute type A aortic dissection. Sixty-nine of them (65%) underwent surgical repair using AXC (with or without femoral artery perfusion), whereas 37 patients had only FAC (35%). The postoperative mortality rate was 29.7% (11/37) in the latter group and 7.2% (5/69) in the former group. Multivariate analysis revealed the absence of auxiliary artery perfusion to be an independent predictor of postoperative mortality (OR = 8.2, \( P = 0.0014 \)). The choice of perfusion technique was not dictated by the extent of repair required, but rather was based on institutional protocols during the different periods of the study.

Reuthebuch et al. [5], retrospectively studying a group of patients (n = 122) undergoing repair of acute type A aortic dissection, reported a postoperative mortality rate of 8.5% (5/62) for AXC and 23.3% (14/60) for FAC. Complications in patients undergoing repair with FAC versus AXC included: prolonged postoperative neurological dysfunction (1.75 vs 17.4%), transient postoperative neurological damage (19.2 vs 30.4%), renal failure (11 vs 23%), visceral malperfusion (4.8 vs 10%, \( P > 0.05 \)), postoperative bleeding (15 vs 31%, \( P < 0.001 \)) and sternal infection (1.6 vs 8.3%, \( P < 0.001 \)).

Orihashi [6] reviewed 59 consecutive cases of acute type A aortic dissection. The majority of patients underwent arterial perfusion through the axillary artery (n = 52, 88%), and only those already in profound haemodynamic instability were cannulated through the femoral artery (n = 7, 12%). Reported mortality was 1 patient in the AXC group (2%) and 3 patients in the FAC group (42.8%). Malperfusion occurred in 4 patients in the AXC group (7.7%) and in 1 patient in the FAC group (14.3%).

Pasic et al. [7] reported a mortality rate of 5% for AXC (1/20) and 22% for FAC (11/50). Postoperative organ malperfusion occurred in 2/20 (10%) patients in the AXC group and in 8/50 (16%) in the FAC group. Major neurological complications were observed in 1/20 (5%) patients in the AXC group and in 4/50 (8%) patients in the FAC group.

Lee et al. [8] assessed 111 patients with acute type A aortic dissection. Fifty-eight patients underwent AXC (n = 58, 52.2%) and 53 underwent FAC (n = 53, 47.7%). The femoral artery was chosen as the inflow site in patients who were either haemodynamically unstable or in those in whom the right axillary artery was involved by the dissecting flap. Postoperative mortality occurred in 5 patients in each group. Moreover, no significant difference was observed between the two groups regarding postoperative complications, which included transient (\( P = 0.37 \)) and permanent (\( P = 0.21 \)) neurological injury, early (\( P = 0.27 \)) and delayed (\( P = 1.00 \)) stroke, resternotomy for bleeding (\( P = 0.44 \)), mediastinitis (\( P = 0.50 \)), myocardial infarction (\( P = 1.00 \)), tracheostomy (\( P = 0.42 \)), haemodialysis (\( P = 1.00 \)), malperfusion (\( P = 1.00 \)) and arterial injury (\( P = 0.50 \)).

Sadi et al. [9] reported no difference in postoperative mortality (\( P = 0.05 \)) and stroke (\( P > 0.05 \)) among patients undergoing surgical repair of acute type A aortic dissection with AXC (n = 12) or FAC (n = 8).

A retrospective analysis on 62 patients with acute type A aortic dissection performed by Etz et al. [10] reported mortality rates of 6% for AXC (2/31) and 19% for FAC (6/31). Overall adverse outcomes, defined as death or stroke, were 50% reduced in the AXC group (3/31 vs 6/31), but did not reach statistical significance (\( P = 0.46 \)).

Battaloglu et al. [11] retrospectively reviewed 41 patients with acute type A aortic dissection. Thirty-five patients underwent AXC (n = 35, 85.4%) and 6 underwent FAC (n = 6, 14.6%). The choice of FAC was dictated by either the presence of haemodynamic instability or pulselessness of the right upper extremity. The authors reported a 14.3% postoperative mortality (n = 5) for AXC and no mortality for FAC. All patients who died had preoperative evidence of malperfusion of one or more organs. Furthermore, postoperative complications occurred in 4 patients in the AXC group (axillary artery injury, visceral ischaemia and axillary artery thrombosis) and in 1 patient in the FAC group (femoral artery thrombosis).

Finally, Etz et al. [12] reviewed 401 consecutive patients undergoing repair of acute type A aortic dissection with antegrade (AXC or direct aortic cannulation, n = 311) or retrograde arterial perfusion (FAC, n = 90). Operative mortality and postoperative stroke did not differ between the two groups (\( P = 0.766 \) and 0.623, respectively), while long-term survival (at 10 years) was significantly improved in favour of antegrade perfusion (\( P = 0.025 \)).

CLINICAL BOTTOM LINE

Patients undergoing repair of type A aortic dissection may benefit from AXC, whenever this is technically feasible. Most reports show that inflow perfusion through the axillary artery will reduce overall mortality, neurological and malperfusion complications when compared with FAC. However, it needs to be stressed that, in three reports, the superiority of AXC over FAC might be attributed to the fact that patients in the latter group were critically ill in haemodynamic collapse. Nevertheless, this indicates that the
### Table 1: Best evidence papers

<table>
<thead>
<tr>
<th>Author, date, journal and country</th>
<th>Patient group</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Meta-analysis (level 1a)</td>
<td>Nine studies (8 retrospective and 1 prospective) with 359 (50.2%) patients in the AXC group and 356 (49.8%) in the FAC group</td>
<td>Postoperative complications</td>
<td>Neurological dysfunction: AXC: 44/307 (14.3%) FAC: 92/349 (26.4%)</td>
<td>The superior neurological results of AXC might be attributed to antegrade cerebral perfusion, use of moderate hypothermia and avoidance of complete circulatory arrest</td>
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<tr>
<td>Retrospective cohort study (level 2b)</td>
<td>n = 49</td>
<td>Univariate analysis of femoral artery cannulation as a predictor of hospital death</td>
<td>RR = 1.6, 95% CI 1.1–2.3, P = 0.02</td>
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<td>Twenty patients underwent right axillary artery cannulation (n = 20, 41%; AXC), and 29 patients underwent FAC (n = 29, 59%)</td>
<td>Multivariate analysis of femoral artery cannulation as a predictor of postoperative neurological deficit</td>
<td>RR = 4.0, 95% CI 1.1–15.0, P = 0.02</td>
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<td>Forty-two patients underwent replacement of the ascending aorta only and another 6 had their aortic arch replaced. One patient died intraoperatively</td>
<td>Femoral artery cannulation as a predictor of need for reoperation</td>
<td>OR = 1.7, 95% CI 1.08–2.8, P &lt; 0.05</td>
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<tr>
<td>Moizumi et al. (2005), Ann Thorac Surg, Japan [4]</td>
<td>Study period: 1992–2004</td>
<td>Operative mortality</td>
<td>AXC and FAC/FAC: 5/69 (7.2%) FAC: 11/37 (29.7%)</td>
<td>AXC is an effective method for improving the results of surgery for acute type A dissection. Its absence is an independent predictor of postoperative mortality in these patients</td>
</tr>
<tr>
<td>Retrospective cohort study (level 2b)</td>
<td>n = 106</td>
<td>Multivariate analysis of the absence of AXC as a predictor of hospital death</td>
<td>OR = 8.2, P = 0.0014</td>
<td>Total arch replacement was not a risk factor for in-hospital mortality, while aortic root replacement was</td>
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<td>Twelve patients (11.3%) underwent right AXC, 57 (53.8%) had AXC/FAC and 37 (34.9%) had only FAC</td>
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<td>Surgical procedures included ascending aortic replacement (n = 62), hemi-arch replacement (n = 21) and total arch replacement (n = 23)</td>
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<tr>
<td>Retrospective cohort study (level 2b)</td>
<td>n = 122</td>
<td>Postoperative complications</td>
<td>Prolonged postoperative neurological dysfunction: AXC: 1/57 (1.7%) FAC: 8/46 (17.4%)</td>
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<td>Sixty-two patients underwent right subclavian cannulation (n = 62, 51%; AXC) and 60 underwent FAC (n = 60, 49%)</td>
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<td>Transient postoperative neurological damage: AXC: 11/57 (19.2%) FAC: 14/46 (30.4%)</td>
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<td>Replacement of the ascending aorta was performed in all patients. Eleven patients underwent additional aortic root replacement, 53 hemi-arch replacement and 7 aortic valve replacement</td>
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FAC: 3/7 (42.8%) | False lumen perfusion has been reportedly reduced but not completely eliminated with preferential use of AXC |
FAC: 11/50 (22%) | Cannulation of the right axillary artery, being technically feasible and safe, may avoid cerebral embolization and organ malperfusion and reduce the rate of neurological and malperfusion complications |
FAC: 5/53 (9.4%)  
P = 0.48 | AXC was not shown to be superior to femoral artery cannulation |
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P = 0.48 | AXC was not shown to be superior to femoral artery cannulation |
| AXC: 7/62 (11%)  
FAC: 14/60 (23%)  
P = 0.023 | | | | |
| Visceral malperfusion:  
AXC: 3/62 (4.8%)  
FAC: 6/60 (10%)  
P > 0.05 | | | | |
| Postoperative bleeding:  
AXC: 10/62 (15%)  
FAC: 19/60 (31%)  
P < 0.001 | | | | |
| Sternal infections:  
AXC: 1/62 (1.6%)  
FAC: 5/60 (8.3%)  
P < 0.001 | | | | |
| Renal failure:  
AXC: 7/62 (11%)  
FAC: 14/60 (23%)  
P = 0.023 | | | | |
| Visceral malperfusion:  
AXC: 3/62 (4.8%)  
FAC: 6/60 (10%)  
P > 0.05 | | | | |
| Postoperative bleeding:  
AXC: 10/62 (15%)  
FAC: 19/60 (31%)  
P < 0.001 | | | | |
| Sternal infections:  
AXC: 1/62 (1.6%)  
FAC: 5/60 (8.3%)  
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<td>All patients underwent replacement of the ascending aorta. In 86 patients, replacement of ascending aorta was extended to the hemi-arch, 6 patients had arch replacement, 12 had root replacement and 7 underwent ascending aortic replacement and AVR</td>
<td>Permanent neurological injury: AXC: 8 (13.8%) FAC: 3 (5.7%) P = 0.21</td>
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<td>Studer et al. (2012), Scand Cardiovasc J, Norway [9]</td>
<td>Study period: 1999–2008 n = 95</td>
<td>Early stroke: AXC: 6 (10.3%) FAC: 2 (3.8%) P = 0.27</td>
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<td>Retrospective cohort study (level 2b)</td>
<td>Twelve patients underwent AXC (12.6%), and 83 underwent FAC (87.4%)</td>
<td>Delayed stroke: AXC: 2 (3.4%) FAC: 1 (1.9%) P = 1.00</td>
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<td>Etz et al. (2008), Ann Thorac Surg, USA [10]</td>
<td>Study period: 1995–2005 n = 62</td>
<td>Resternotomy for bleeding: AXC: 5 (8.6%) FAC: 2 (3.8%) P = 0.44</td>
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<td>Mediastinitis: AXC: 2 (3.4%) FAC: 0 P = 0.50</td>
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<td>Myocardial infarction: AXC: 1 (1.7%) FAC: 0 P = 1.00</td>
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<td>Tracheostomy: AXC: 2 (3.4%) FAC: 4 (7.5%) P = 0.42</td>
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<td>Haemodialysis: AXC: 2 (3.4%) FAC: 2 (3.8%) P = 1.00</td>
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<td>Malperfusion: AXC: 1 (1.7%) FAC: 0 P = 1.00</td>
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<td>Arterial injury: AXC: 2 (3.4%) FAC: 0 P = 0.50</td>
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<td>Operative mortality: AXC: 0/12 (0%) FAC: 14/83 (16.9%) P &gt; 0.05</td>
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<td>Postoperative complications: Stroke: AXC: 2/12 (17%) FAC: 20/83 (23%) P &gt; 0.05</td>
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<td>Although the majority of patients underwent acute type A aortic dissection repair with FAC, no difference in terms of morbidity or mortality was demonstrated between the two groups</td>
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<td>A 50% decrease in adverse outcomes was observed in patients with AXC</td>
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femoral artery remains a bailout option in the emergency situation when institution of CPB is required rapidly.

Conflict of interest: none declared.

REFERENCES


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<td>Battaloglu et al. (2008), J Card Surg, Turkey [11]</td>
<td>Retrospective cohort study (level 2b)</td>
<td>Study period: 2000–2006</td>
<td>Operative mortality</td>
<td>AXC: 5/35 (14.3%)</td>
<td>Right AXC for repair of acute type A aortic dissection is a feasible and safe procedure with acceptable morbidity and mortality. Femoral arterial cannulation should be kept in mind if there is evidence of pulelessness of the right upper limb or when CPB is required before sternotomy</td>
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<tr>
<td>Battaloglu et al. (2008), J Card Surg, Turkey [11]</td>
<td>Retrospective cohort study (level 2b)</td>
<td>n = 41 Thirty-five patients (85.4%) underwent right AXC and 6 (14.6%) underwent FAC</td>
<td>Postoperative complications</td>
<td>AXC: 0/6 FAC: 1/6 (16.7%) (femoral artery thrombosis)</td>
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<tr>
<td>Battaloglu et al. (2008), J Card Surg, Turkey [11]</td>
<td>Retrospective cohort study (level 2b)</td>
<td>Indications for FAC: Cardiac arrest and ongoing cardiopulmonary resuscitation in 1 patient and pulselessness of the right upper limb in 5 patients</td>
<td>Postoperative complications</td>
<td>AXC: 2/35 (5.7%) FAC: 1/6 (16.7%)</td>
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<td>Battaloglu et al. (2008), J Card Surg, Turkey [11]</td>
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