Best evidence topic - Aortic and aneurysmal

Which cannulation (ascending aortic cannulation or peripheral arterial cannulation) is better for acute type A aortic dissection surgery?

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Summary

A best evidence topic in cardiac surgery was written according to a structured protocol. The question addressed was ‘Which cannulation (ascending aortic cannulation or peripheral arterial cannulation) is better for acute type A aortic dissection surgery?’ Altogether 393 papers were found using the reported search, of which 14 represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers are tabulated. Femoral artery cannulation has the highest rate of mortality, stroke rate and other complications including retrograde cerebral embolization, organ malperfusion and perfusion of the false lumen. Five out of 14 papers were found to be reporting in favour of axillary (or subclavian) artery cannulation over femoral artery cannulation. In a total of 1829 patients evaluated in these studies, 1068 patients demonstrated a significantly lower complication rate with axillary artery cannulation than femoral artery cannulation. Some of the larger studies showed femoral artery cannulation has higher mortality and stroke rates ranging from 6.5% to 40% and 3% to 17%, respectively. Meanwhile, mortality and stroke rates were ranging from 3% to 8.6% and 1.75% to 4%, respectively, in the favour of axillary artery cannulation. A total of seven studies evaluated direct aortic cannulation for the establishment of cardiopulmonary bypass (CPB). They demonstrated mortality and stroke rates from 0% to 15% and 3.8% to 21%, respectively. Central cannulation has promising results with a lower mortality rate but a higher stroke rate. Direct cannulation of the true lumen is a promising method for quick and easy establishment of CPB. Axillary artery cannulation with a side graft, although it takes more time to construct, is proven to be safe and straightforward, with fewer local and systemic complications including lower mortality and neurological complications.

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Keywords: Type A aortic dissection; Cannulation

1. Introduction

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

2. Three-part question

In [patients, undergoing surgery, for acute type A aortic dissection] is [central ascending aorta cannulation] better than [peripheral arterial cannulation] to reduce [morbidity, stroke rate and mortality]?

3. Clinical scenario

You are planning an emergency repair of a type A aortic dissection. Your usual technique is to use femoral arterial cannulation, but the last time you used this technique the patient suffered a postoperative stroke. You wonder whether and alternative method of cannulation would reduce the chance of this complication.

4. Search strategy

The search was performed using http://highwire.stanford.edu interface. The search terms used were: acute type A aortic dissection, axillary, femoral and aortic cannulation.

5. Search outcome

Three hundred and ninety-three papers were found using the reported search. From these 14 papers were identified that provided the best evidence to answer the question. These are presented in Table 1.

6. Results

Recently, Kamiya et al. [2] analysed the results of 235 patients undergoing surgery for acute type A aortic dissection using direct ascending aortic cannulation and percutaneous femoral artery cannulation. These authors showed that ascending aortic cannulation has lower mortality than femoral artery cannulation. However, there were no signif-
Table 1
Best evidence papers

<table>
<thead>
<tr>
<th>Author, date and country, Study type (level of evidence)</th>
<th>Patient group</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Incidence of stroke</td>
<td>4.9% – Aortic group 4.5% – Femoral group</td>
<td>Both ascending aortic and femoral artery cannulation is accepted mean of cannulation</td>
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<td></td>
<td></td>
<td>Long-term survival</td>
<td>5 years: 65% – Aortic group 64% – Femoral group</td>
<td>Site of cannulation should be chosen depending upon individual patients status</td>
</tr>
<tr>
<td>Khaladj et al., (2008), Eur J Cardiotorac Surg, Germany, [3] Retrospective cohort study (level 2b)</td>
<td>122 patients underwent central ascending aortic cannulation from November 1999 to February 2006 using the Seldinger technique</td>
<td>Mortality (30 days)</td>
<td>15%</td>
<td>Central cannulation by Seldinger technique is safe, quick, straight forward and easy to established</td>
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<tr>
<td></td>
<td></td>
<td>Incidence of stroke</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Reece et al., (2007), J Thorac Cardiovasc Surg, USA, [4] Retrospective cohort study (level 2b)</td>
<td>70 patients from July 1996 to July 2005 underwent: – Central ascending aortic cannulation using the Seldinger technique (n=24) – Peripheral (femoral + axillary) cannulation (n=46) by arterial cutdown</td>
<td>Mortality (30 days)</td>
<td>0% – Central group 17% – Peripheral group</td>
<td>The aortic cannula was held in place by hand during cooling, which makes this procedure little uncomfortable</td>
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<tr>
<td></td>
<td></td>
<td>Incidence of stroke</td>
<td>21% – Central group 28% – Peripheral group</td>
<td></td>
</tr>
<tr>
<td>Reuthebuch et al., (2004), Eur J Cardiotorac Surg, Switzerland, [5] Retrospective cohort study (level 2b)</td>
<td>From January 1997 to January 2003, 122 patients underwent surgery for acute type A aortic dissection – Subclavian group, SG (n=62), – Femoral group, FG (n=60) Both cannulations are carried out by direct exposure and arterial cutdown</td>
<td>Mortality</td>
<td>8.6% – Subclavian group 23.3% – Femoral group</td>
<td>Unilateral subclavian artery approach provides antegrade cerebral perfusion leading to remarkable brain protection</td>
</tr>
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<td></td>
<td></td>
<td>Prolonged postoperative neurological dysfunction</td>
<td>1.75% – Subclavian group 17.4% – Femoral group</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Renal failure</td>
<td>11% – Subclavian group 23% – Femoral group</td>
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<tr>
<td>Sabik et al., (2004), Ann Thorac Surg, USA, [6] Observational clinical case-control study (level 3b)</td>
<td>From 1993 to January 2001, 391 patients underwent axillary artery (direct or with a side graft) cannulation for different cardiac surgical procedure. Among these 85 patients operated for type A aortic dissection</td>
<td>Mortality</td>
<td>8% for entire cohort 7.6% – Direct cannulation 8.6% – With side graft cannulation</td>
<td>Low-risk of malperfusion during axillary artery cannulation</td>
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<td></td>
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<td>Local complication (brachial plexus injury)</td>
<td>2.8% – Direct cannulation 0.5% – With side graft cannulation</td>
<td>Most common complication of axillary artery cannulation is axillary artery and brachial plexus injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aortic dissection</td>
<td>1.4% – Direct cannulation 0% – With side graft cannulation</td>
<td>Complication can be reduced with side graft cannulation</td>
</tr>
<tr>
<td>Svensson et al., (2004), Ann Thorac Surg, USA, [7] Cohort study (level 2b)</td>
<td>1336 patients underwent complex cardiac surgical procedure using different cannulation sites: Aorta – 471, Femoral – 374, Ax + SG – 299, Ax no SG – 167, External iliac – 1,</td>
<td>Mortality</td>
<td>7.0% – Ax + SG 7.8% – Ax no SG 7.0% – Aorta 11% – Femoral 12% – Innominate</td>
<td>Axillary artery cannulation with side graft on it allows safer complex cardiac operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stroke</td>
<td>4.0% – Ax + SG 7.8% – Ax no SG 6.4% – Aorta</td>
<td>This study analysed not only type A aortic dissection patients</td>
</tr>
</tbody>
</table>

(Continued on next page)
<table>
<thead>
<tr>
<th>Author, date and country, Study type (level of evidence)</th>
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<tr>
<td>Chiappini et al., (2005), Eur Heart J, Italy, The Netherlands, [8]</td>
<td>From 1976 to 2003, 487 patients were operated on for acute type A aortic dissection. Majority (98.2%) of them were operated using femoral cannulation</td>
<td>Mortality</td>
<td>22%</td>
<td>Major brain damage, visceral ischaemia and ascending aorta rupture were main causes of death</td>
</tr>
<tr>
<td>Fusco et al., (2004), Ann Thorac Surg, USA, [9]</td>
<td>Total 86 patients underwent surgery for type A Ao dissection, out of which seventy-nine were cannulated through femoral artery from 1981 to 2003</td>
<td>Death</td>
<td>12.9%</td>
<td>Only two deaths (1.5%) were directly related to femoral cannulation. Out of seven patients having CVA, four were severely unstable before arrival in operating room</td>
</tr>
<tr>
<td>Conzelmann et al., (2009), Ann Thorac Surg, Germany, [10]</td>
<td>Between April 2004 and August 2007, 29 patients underwent surgery for Ao dissection by direct true lumen cannulation after opening of the ascending aorta</td>
<td>Mortality</td>
<td>0%</td>
<td>Direct true lumen cannulation is technically feasible in all patients</td>
</tr>
<tr>
<td>Inoue et al., (2007), Eur J Cardiothorac Surg, Japan, [12]</td>
<td>Thirty-two patients with type A Ao dissection underwent surgery by direct ascending aortic cannulation using Seldinger technique in addition to femoral artery cannulation to establish CPB</td>
<td>Mortality</td>
<td>3.1%</td>
<td>Femoral cannulation has been carried out to establish CPB, which is time-consuming</td>
</tr>
<tr>
<td>Nouraei et al., (2007), Asian Cardiovasc Thorac Ann, UK, [13]</td>
<td>Forty-nine patients with acute type A aortic dissection were studied between 1999 and 2004. CPB was established using: – Femoral artery (n=29) – Subclavian artery (n=20)</td>
<td>Hospital mortality</td>
<td>Femoral – 40% Subclavian – 10%</td>
<td>Lower incidence of re-operation in subclavian group (odds ratio 1.7; 95% CI)</td>
</tr>
<tr>
<td>Etz et al., (2008), Ann Thorac Surg, USA, [14]</td>
<td>From 1990 to 2005, 869 patients undergoing complex aortic surgery were included out of which 171 patient were with chronic and acute dissection. Patients were divided according to site of cannulation as followed: Aortic – 157 Femoral – 261</td>
<td>Hospital mortality</td>
<td>All cause Aorta – 5.1% Femoral – 6.5% Axillary – 3.3% Chronic aortic dissection Aorta – 11% Femoral – 9% Axillary – 12% Acute aortic dissection</td>
<td>Axillary artery cannulation has proved to be the preferred cannulation site in complex aortic surgery</td>
</tr>
</tbody>
</table>

(Continued on next page)
Khaladj and co-workers [3] concluded ascending Ao cannulation using the Seldinger technique was a safe, quick and easy to establish. In a review of 122 patients, mortality at 30 days was 15%, which matches statistics reported in other studies. They observed 12% stroke rate and 17% temporary neurological dysfunction.

Reece et al. [4] have shown 0% mortality and 21% stroke rate in ascending aortic cannulation using the Seldinger technique, while there was a 17% mortality and a 28% stroke rate in the peripheral artery cannulation group (femoral and axillary). Furthermore, they suggest that the site of cannulation should be tailored to both the specificities of dissection and the patient. If a clot is present in the false lumen, an alternative cannulation technique in the ascending aorta should be considered.

Reutebuch and co-authors [5] compared two peripheral cannulations, subclavian artery vs. femoral artery, in 122 patients undergoing surgery for acute type A aortic dissection. They have shown subclavian artery cannulation has lower mortality (8.6% vs. 23.3%), lower prolonged postoperative neurological dysfunction (1.75% vs. 17.4%) and lower renal failure (11% vs. 23%). Extension of dissection to the cerebral vessels, ascending aorta, and infrarenal abdominal aorta were higher in femoral group.

Sabik et al. [6] specified and studied the effect of axillary artery cannulation with a side graft (SG) and without a SG in 391 patients. In their study, the overall mortality was 8%. They concluded that axillary artery cannulation with or without SG has similar mortality, but axillary cannulation with SG can decrease local complication (e.g. brachial plexus injury) up to 0.5% vs. 2.8% and risk of aortic dissection to 0% vs. 1.4%. Overall, axillary artery cannulation can decrease organ malperfusion, retrograde embolization and other complications related to peripheral cannulation.

From the Cleveland Clinic, Svensson and co-workers [7] reviewed results of a large cohort of 1336 patients, undergoing complex cardiac surgeries using different cannulation techniques like aortic (n=471), axillary with SG (Ax+SG) (n=299), axillary with no SG (Ax no SG) (n=167), femoral (n=374) and innominate artery (n=24). Among all these cannulation techniques, Ax+SG has the lowest mortality (7.0%) and stroke (4.0%) rate. Interestingly, stroke rate is higher (7.8%) in the Ax no SG group. Although, they studied other patients not only those undergoing surgery for type A aortic dissection, they showed axillary artery cannulation to be the preferred method of cannulation for complex aortic surgery and re-operations.

Chiappini et al. [8] reviewed the result of 487 patients treated for acute type A aortic dissection in Italy and The Netherlands. Most of the surgeries (98.2%) were performed using femoral artery cannulation for the establishment of the cardiopulmonary bypass (CPB). In their patients, mortality rate was 22% and stroke rate was 18.2%.

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**Table 1 (Continued)**

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<tr>
<td>Budde et al., (2006), Ann Thorac Surg, USA, [15] Retrospective cohort study (level 2b)</td>
<td>Sixty-one patients (41 – elective, 20 – emergent) undergoing surgery for acute ascending aortic syndrome (dissection and intramural haematoma) were cannulated through the axillary artery for CPB</td>
<td>Neurological dysfunction</td>
<td>Overall – 4.9% Stroke rate All cause</td>
<td>Shorter hospital stays in the elective group</td>
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<td></td>
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<td>Electro surgical – 4.8%</td>
<td>Overall stroke rate of 1.6% must likely be due to embolic debris, suggesting that the type of perfusion did not contribute to this complication</td>
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<td></td>
<td></td>
<td></td>
<td>Elective surgery – 4.8%</td>
<td>Stroke rate in the peripheral artery cannulation group is 0% vs. 2.8% and risk of aortic dissection to 0% vs. 1.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Emergent surgery – 4.8%</td>
<td>Overall mortality was 8%</td>
</tr>
</tbody>
</table>

Ax + SG, axillary with SG; Ax no SG, axillary with no SG; CVA, cerebrovascular accident; CPB, cardiopulmonary bypass; CI, confidence interval; SG, side graft.
Fusco et al. [9] retrospectively studied 86 patients treated for acute aortic dissection. Seventy-nine of them were cannulated through the femoral artery. Fifteen patients died, out of which, only two had documented femoral artery cannulation as a related cause of death and one had an aortic cannulation related death. They concluded that femoral artery cannulation was not the main cause of death and stroke.

Unlike others, Conzelmann et al. [10] first performed venous drainage and then opened the ascending aorta followed by direct true lumen cannulation during type A aortic dissection surgery. They observed 0% mortality and 21% neurological complications. They proved that technical simplicity and the quick establishment of an additional arterial access was a major advantage when performing surgery of aortic dissections.

Moizumi et al. [11] compared the results of surgery for acute type A aortic dissection using the femoral and axillary arteries in a retrospective study of 106 patients. In univariate and multivariate analysis, absence of axillary artery perfusion is shown to be an independent intraoperative predictor of hospital death. Mortality rate was 7.2% in the axillary group and 30% in the femoral group, proving axillary artery cannulation to be an effective method of cannulation in improving the results of surgery for acute type A aortic dissection.

Inoue et al. [12] conducted a study on direct ascending aortic cannulation using the Seldinger technique, guided by epiaortic ultrasound, in 32 patients undergoing surgery for acute type A aortic dissection. They established CPB using femoral artery cannulation before switching to ascending aortic cannulation. A mortality rate of 3.1% and neurological complication of 6.3% was found. Although, no complication related to the extension of the dissection, false lumen or malperfusion occurred in their series; this technique is time consuming and has the potential risk of retrograde embolization.

In 2007, Nouraei et al. [13] retrospectively reviewed the results of 49 patients operated on for acute type A aortic dissection using femoral and subclavian artery cannulation over a five-year period. In their series of cases, the subclavian cannulation group had a lower mortality rate (10%), while univariate analysis showed femoral cannulation as a significant predictor of neurological deficit and mortality.

Analysing a large cohort of 869 patients with complex aortic pathologies, Etz et al. [14] have shown that the use of axillary artery cannulation for CPB lowers the mortality and stroke rate compared to direct ascending aorta and femoral artery cannulation.

Budde et al. [15] used axillary cannulation to establish CPB in 61 patients undergoing elective and emergent surgery for acute ascending aortic syndrome. There were no significant difference in postoperative temporary neurological dysfunction and mortality in elective and emergent groups: 4.9% vs. 5% and 7.3% vs. 10%, respectively. They claimed that the use of axillary artery cannulation in emergent cases was appropriate, efficacious and safe in an elective setting.

7. Clinical bottom line

Several cannulation techniques have been proposed to establish CPB for surgery of acute type A aortic dissection. In spite of concern over the fragility of vessels and distal embolization during ascending aortic cannulation of a dissected aorta, it has promising results with a lower mortality rate, a lower incidence of malperfusion but has a higher stroke rate. A total of seven studies evaluated direct aortic cannulation for the establishment of CPB. They demonstrated mortality and stroke rates from 0% to 15% and 3.8% to 21%, respectively. Direct cannulation of the true lumen is an emerging method for quick and easy establishment of CPB. Although, femoral artery cannulation is the standard option in many centres, it has the highest rate of mortality, stroke rate and other complications including retrograde cerebral embolization, organ malperfusion and perfusion of the false lumen. Five out of 14 papers were found to report in favour of axillary (or subclavian) artery cannulation over femoral artery cannulation. In a total of 1829 patients evaluated in these studies, 1068 patients demonstrated a significantly lower complication rate with axillary artery cannulation than femoral artery cannulation. Some of the larger studies showed that femoral artery cannulation has higher mortality and stroke rates ranging from 6.5% to 40% and 3% to 17%, respectively. Meanwhile, mortality and stroke rates ranged from 3% to 8.6% and 1.75% to 4%, respectively, in favour of axillary artery cannulation. Axillary artery cannulation emerges as an elegant method for CPB. It provides continuous unilateral blood flow without interruption. Although it takes more time to construct, axillary artery with a SG is proven to be safe and straightforward, with fewer local and systemic complications, lower mortality and neurological complications.

References

[8] Chiappini B, Schepens M, Tan E, Dell’Amore A, Morshuis W, Dossche K,


eComment: Outcome in patients requiring surgery for acute aortic dissection type A: Just a matter of cannulation site?

Authors: Nawid Khaladj, Hannover Medical School Cardiac, Thoracic, Transplantation and Vascular Surgery, Hannover, Germany; Sven Peterss, Axel Haverich, Christian Hagl
doi:10.1510/icvts.2009.230409A

We have read with interest the best evidence topic report by Tiwari and co-workers dealing with the issue of cannulation site in patients requiring surgery for acute aortic dissection type A [1]. As stated by the authors, our group has substantial experience in direct cannulation of the dissected aorta. Unfortunately, our technique has not been cited correctly [2]. In contrast to other groups, the Hannover technique relies on direct approaching the aorta in a less dissected or non-dissected area, as determined by CT-scan or transesophageal echocardiography. The cannula is supported by double purse-string sutures.

We are aware that the routine use of this technique in elective patients with thin-walled aortic aneurysms is a prerequisite for this specific approach, including troubleshooting strategies in case of aortic rupture or mal-perfusion.

There is no question that neurological complications are a multi-factorial process in this high-risk patient cohort. Nevertheless, temporary neurological complications as well as frank strokes can be dedicated by the underlying pathology but also cerebral protection techniques [3]. However, when cannulation techniques are applied to establish antegrade flow, they are frequently combined with selective antegrade cerebral perfusion which is often associated with better neurological outcome [4].

In most of the published studies, it remains unclear whether strokes were counted if the patients died during hospital stay. This is an important information, as it has been shown that mortality rates are higher in patients suffering from peri-operative strokes.

Clear guidelines for reporting mortality and morbidity after aortic surgery are therefore mandatory, according to the current ones published for valve surgery [5].

References


