Direct cannulation of the Axillary artery for cardiopulmonary bypass is safe and non-inferior to Axillary artery cannulation using a side graft

Background/ Objectives

- The axillary artery is a common alternative arterial cannulation site for certain cases requiring cardiopulmonary bypass.

- Previous studies have found direct axillary artery cannulation (AAC) associated with an increased risk of stroke and cannulation-related complications compared to cannulation with a side graft.[1,2]

- We sought to analyze our institutional experience and hypothesized that there would be no difference in stroke rates by the AAC method.

1 Puiu PC, Pingpoh C, Beyersdorf F, et al. *Ann Thorac Surg*. 2021;112(5):1433-1440.

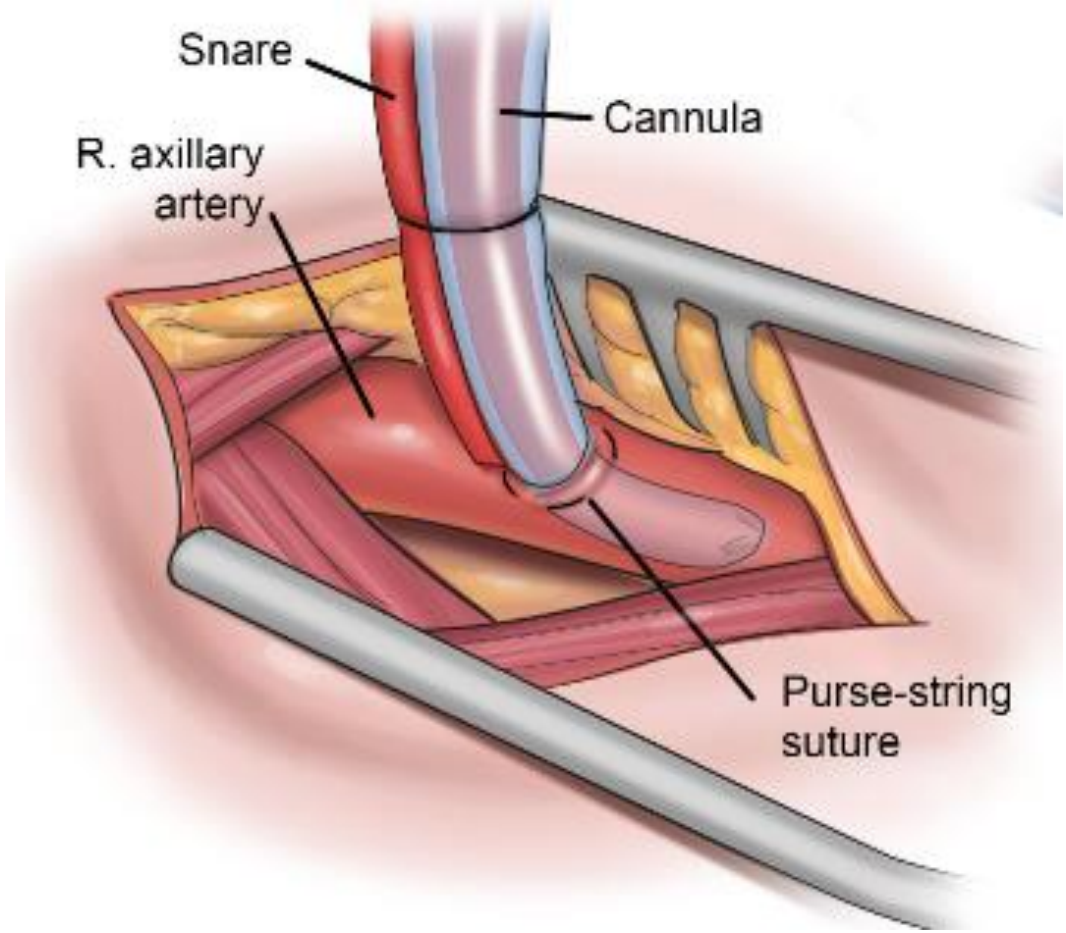
2 Sabik JF, Nemeh H, Lytle BW, et al. *Ann Thorac Surg*. 2004;77(4):1315-1320.

Methods

- We identified all patients who underwent AAC between January 2011 and June 2022 using our institutional Society of Thoracic Surgeons adult cardiac surgery database.
- The cannulation method was performed at the surgeons' discretion. A chart review was performed to confirm the AAC method, and patients were divided based on axillary artery cannulation technique – direct cannulation (n=131) or side graft cannulation (n=333)
- EMR was used to measure the axillary artery diameter, and to obtain additional outcomes of axillary artery cannulation-related complications.
- The primary outcome was stroke, and secondary outcomes included operative mortality, axillary artery cannulation site complications, blood product use, reoperation, and new dialysis requirement.
- Baseline demographics, operative characteristics, and outcomes were compared using Wilcoxon rank sum test or Fisher's exact test as appropriate.

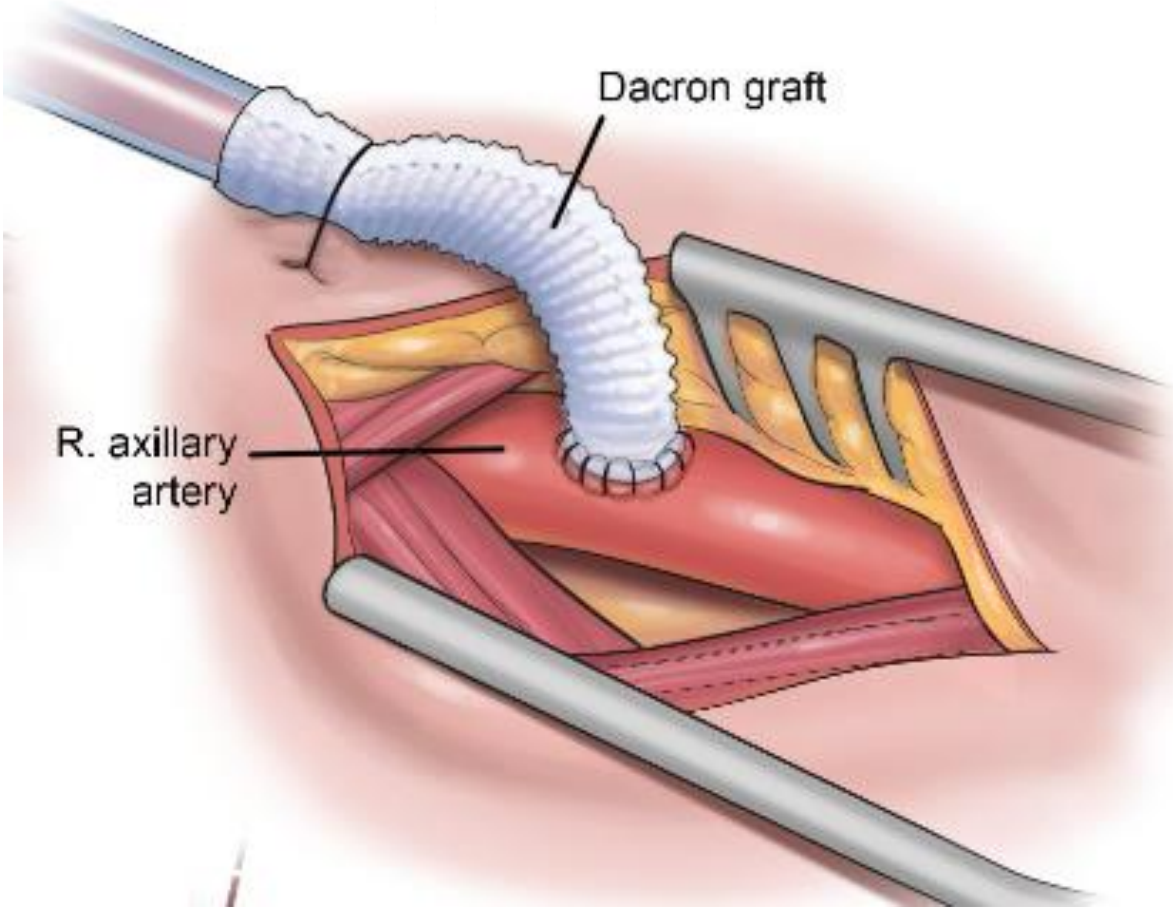
Study Cohorts

Direct Cannulation (n=131)



VS

Side graft (n=333)



Arminder S. Jassar, Thoralf M. Sundt, III, STS Cardiothoracic Surgery E Book, Ch: Hypothermic circulatory arrest

Results

Baseline Characteristics	Direct (n=131)	Side Graft (n=333)	p-value
Male	91 (69.5%)	223 (67.0%)	0.60
Age	68.0 (57.0-75.0)	65.0 (54.0-73.0)	0.09
Body mass index (kg/m2)	27.2 [24.0-30.4]	26.6 [23.5-31.1]	0.48
Diabetes	20 (15.3%)	64 (19.2%)	0.32
Hypertension	116 (88.5%)	263 (79.0%)	0.02
Preoperative creatinine	1.0 (0.9-1.3)	1.0 (0.8-1.3)	0.40
Chronic lung disease	20 (15.3%)	52 (15.6%)	>0.99
Immunocompromised	9 (6.9%)	28 (8.4%)	0.58
Peripheral Vascular Disease	41 (31.3%)	120 (36.0%)	0.33
Cerebrovascular Disease	33 (25.2%)	83 (24.9%)	0.95
Previous PCI	10 (7.6%)	41 (12.3%)	0.15
Cardiogenic shock	8 (6.1%)	10 (3.0%)	0.12
Connective tissue disorder	5 (3.8%)	33 (9.9%)	0.18
Pathology			0.06
Aneurysm without Dissection	25 (19.1%)	60 (18.0%)	
Acute Type A Dissection	67 (51.1%)	131 (39.3%)	
Degenerative Aneurysm/Chronic Dissection	14 (10.7%)	44 (13.2%)	
Other	25 (19.1%)	98 (29.4%)	

- **Higher proportion of hypertension in the direct axillary artery cannulation group;** other characteristics were similar.
- **No difference in BMI, peripheral vascular disease, or aortic pathology between groups**

OPERATIVE CHARACTERISTICS

Direct cannulation

- Slightly larger median axillary artery diameter
  - 8.1 mm vs 7.8
- Higher proportion of aortic reoperation
  - 26% vs 17%
- More partial arch replacements
  - 20% vs 9%
- More circulatory arrest
  - 83% vs 71

Side graft

- Longer median procedure time
  - 428 mins vs 404

Operative Characteristics	Direct (n=131)	Side Graft (n=333)	p-value
Procedure Status			0.16
Elective	43 (32.8%)	126 (37.8%)	
Urgent	32 (24.4%)	96 (28.8%)	
Emergent	56 (42.7%)	111 (33.3%)	
Reoperation	42 (32.1%)	132 (39.8%)	0.12
- Reoperation from prior aorta procedure	34 (26.0%)	57 (17.1%)	0.04
- Reoperation from prior CABG	12 (9.2%)	19 (5.7%)	0.18
- Reoperation from prior valve	11 (8.4%)	50 (15.0%)	0.06
Axillary Artery Diameter (mm), median	8.1 [7.5-9.0]	7.8 [6.9-8.6]	<0.01
Procedure*			
Aortic root procedure	46 (35.1%)	146 (43.8%)	0.09
Ascending aorta replacement (only)	42 (32.1%)	95 (28.5%)	0.45
Hemiarch replacement	25 (19.1%)	72 (21.6%)	0.55
Partial arch replacement	26 (19.8%)	29 (8.7%)	<0.01
Total arch replacement	16 (12.2%)	52 (15.6%)	0.35
Elephant trunk or frozen elephant trunk	18 (13.7%)	50 (15.0%)	0.73
CABG	23 (17.6%)	45 (13.5%)	0.27
AVR	35 (26.7%)	86 (25.8%)	0.84
MVR/r	6 (4.6%)	26 (7.8%)	0.22
Other	19 (14.5%)	68 (20.4%)	0.15
Procedure time (minutes)*	404.1 [329.9-515.5]	428.2 [353.9-543.9]	0.04
Cardiopulmonary bypass time (minutes)*	223.0 (176.0-302.0)	230.0 (188.0-296.0)	0.65
Cross clamp time (minutes)*	145.0 (93.0-206.0)	162.5 (105.0-228.5)	0.06
Cases with circulatory arrest (n)	109 (83.2%)	237 (71.2%)	0.01
- Circulatory arrest time (minutes)*	33.5 [25.0-69.0]	36.0 [23.0-72.0]	0.86

* = Procedures are not mutually exclusive except for aortic replacement procedures. ** = median +/- IQR

Perioperative Outcomes

	Direct (n=131)	Side Graft (n=333)	p-value
Primary Outcome			
Stroke	13 (9.9%)	28 (8.4%)	0.59
Secondary Outcomes			
Operative Mortality	11 (8.4%)	29 (8.7%)	>0.99
Axillary Cannulation Site Complications	3 (2.3%)	7 (2.1%)	>0.99
- Right arm neuro deficit (not related to stroke)	2 (1.5%)	3 (0.90%)	0.62
- Need for surgical/stent repair	0	2 (0.60%)	>0.99
- Arm Malperfusion	1 (0.80%)	2 (0.60%)	>0.99
Blood Products Used	85 (64.9%)	221 (66.4%)	0.83
RBC units transfused	3.0 [2.0-8.0]	3.0 [1.0-6.0]	0.21
FFP units transfused	0.0 [0.0-2.0]	0.0 [0.0-2.0]	0.24
Platelet packs transfused	0.0 [0.0-1.0]	0.0 [0.0-1.0]	0.71
Reoperation for bleeding	10 (7.6%)	31 (9.3%)	0.72
Unplanned Reoperation for Other Reason	5 (3.8%)	6 (1.8%)	0.31
New Dialysis Requirement	16 (12.2%)	27 (8.1%)	0.21

- **No difference in the primary outcome of stroke** between groups (9.9% direct vs 8.4% side graft,p=0.59).
- **No difference in the secondary outcomes** of operative mortality, axillary cannulation site complications, blood products used, reoperation, or new dialysis requirements.

Limitations

- Retrospective study design, which is subject to bias related to surgeon expertise and patient selection
- Limited sample size

Conclusions

- Overall complications from axillary artery cannulation site related issues were low.

- **There was no difference in stroke rate or cannulation-related complications between direct versus side graft cannulation of the axillary artery** in our institutional cohort, specifically no increased incidence of arm malperfusion in the direct cannulation cohort.

- **Direct axillary artery cannulation had a shorter median procedure time.**

- These findings suggest that direct axillary artery cannulation is a safe technique for arterial cannulation.