Commentary: Does right axillary artery cannulation prevent aorto-cerebral embolic phenomena?

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Central Message

Right axillary artery cannulation for arch reconstruction is safe and effective, but large randomized, controlled trials are needed to prove whether it is superior to other cannulation techniques.

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In this month's issue of the *Journal*, Kim and colleagues¹ present their retrospective analysis evaluating, by means of a propensity score–matching technique, the rate of early stroke and mortality after aortic arch replacement with right axillary cannulation compared with nonaxillary cannulation. Kim and colleagues¹ from Seoul are to be congratulated both for the results demonstrated and for their thoughtful analysis. This article is timely because the issue of determining the optimal cannulation strategy for arch reconstruction remains unresolved, with distinctly inadequate high-quality, in terms randomized, controlled trial–derived, large-volume data to draw conclusions. To that end, this current data set does add to the primary literature, albeit with several important limitations. Kim and colleagues¹ separated a set of 468 patients into those who received right axillary cannulation and those who underwent access through alternative arterial sites. This amounted to 352 patients in the axillary group and 116 in the “nonaxillary” group. Kim and colleagues¹ then matched 116 patients from the axillary group with the nonaxillary group patients on the basis of 23 preoperative factors. A propensity score–matched analysis comparing axillary with nonaxillary cannulation demonstrated significant differences in stroke rate and both 30-day and in-hospital mortalities (2.6%, 2.6%, and 2.6%, vs 8.6%, 8.6%, and 9.5%, respectively.) In light of this result, Kim and colleagues¹ have concluded that axillary cannulation specifically “reduced the rate of early embolic stroke and early mortality.”

Despite the lower stroke rate and mortalities demonstrated, this conclusion may be overreaching. Most importantly, it should be noted that nearly 70% of the axillary group's patients were eliminated in the matching process, representing a very meaningful amount of data loss and thus significantly dampening the power of the analysis. Moreover, a large percentage of the matched axillary group (43%) also underwent cannulation at another site

(ascending aorta or femoral artery), although it is not clear why these patients had dual cannulation. Were there intraoperative issues of malperfusion with isolated axillary cannulation in some patients that provoked a second cannulation, or vice versa? If so, it seems likely that inclusion of dually cannulated patients in this analysis makes it at the least difficult to conclude (without controlling for cannulation technique) that axillary cannulation alone definitively reduced complication rates. Germane to this concern is that the details of the patients' preoperative and operative characteristics among those who had a stroke or died are not provided. Given the relatively small data set used for the propensity score matching and the mixed set of patients with respect to emergency status (eg, acute aortic dissections) or extent of arch reconstruction (hemiarch vs total arch), it is distinctly relevant whether there were any recurring factors present among those patients who died or had a stroke that either contributed to or confounded other risk factors, such as cannulation strategy. Moreover, some of the patients in both groups also received direct ostial carotid cannulation for unilateral or bilateral cerebral perfusion, and this factor was not used in the matching process. This omission in the matching process is perplexing, because direct cannulation of the carotid arteries through the open arch represents a clear mechanism for the introduction of air or

particulate emboli into the cerebral circulation. Some of these concerns might have been dampened had Kim and colleagues¹ used an analytic technique that prevented significant data loss, such as inverse probability weighting, on the whole data set, rather than choosing a propensity score-matching technique.

Second, the data for this analysis were harvested entirely by retrospective chart review, which allows significant error in outcome detection, particularly stroke. In this regard, although some patients with stroke received a neurology consult, neither cohort was rigorously screened by neurologist adjudication or cross-sectional imaging (optimally magnetic resonance imaging) for stroke postoperatively, and yet it has become clear that surgeon-adjudicated stroke rates, especially as revealed retrospectively by chart review, are distinctly inaccurate.² A recent small randomized, controlled trial compared the use of antegrade cerebral perfusion with that of retrograde cerebral perfusion in patients undergoing elective hemiarch replacement, with all patients having right axillary artery cannulation for cardiopulmonary bypass inflow. All patients had formal preoperative and postoperative neurologist examinations and magnetic resonance imaging, which revealed clinically evident stroke rates of 11% and 9%, respectively, and strikingly, the magnetic resonance imaging-proven cerebral infarct rate was 100% in the antegrade group but only 45% in the retrograde group.³ Interestingly, there was no difference in the relative frequency of right- to left-sided emboli in this well-controlled study. In contradistinction, Kim and colleagues¹ posit that right axillary cannulation will specifically reduce right-sided cerebroembolic phenomena because of the retrograde blood flow pattern down the innominate artery. They also declare that “most embolic strokes...are caused by mobilization of aortic atheroma...commonly, by a ‘sandblasting effect.’” The distinct cause of cerebroembolic events and the source from which emboli come in the context of arch reconstruction, however, are rarely known and have yet to be clarified by any study.

Notwithstanding the association that Kim and colleagues¹ have shown between the use of right axillary arterial cannulation and a lower stroke rate and mortality in their hands, there are major concerns of the existence of both contributing and confounding factors in their cohorts that cloud the relative contribution of right axillary artery cannulation specifically to stroke and mortality reduction. To date, there have been five low-volume randomized, controlled trials in human patients and several large database and meta-analyses comparing antegrade cerebral perfusion (most often delivered by right axillary artery cannulation) with retrograde cerebral perfusion, and these studies have generally revealed no difference in stroke and mortality or, especially with respect to stroke, they actually have been in favor of retrograde cerebral perfusion

with central cannulation.³⁻¹⁰ The inclusion of both elective and emergency cases, particularly with only 116 patients in each group, opacifies the issue further. In a study of 264 consecutive acute type A aortic dissection cases, when stratified by cannulation strategy alone, both stroke rate and mortality were significantly lowest with central cannulation, followed by axillary cannulation, then by femoral cannulation.¹¹ It thus seems overreaching and premature to conclude that right axillary artery cannulation in and of itself reduces both stroke and mortality in the context of arch reconstruction. Despite the demonstration by Kim and colleagues¹ of an association between lower stroke rate and mortality and right axillary cannulation in their practice, the vast worldwide experience is neither consistent nor confirmatory in this regard. It is important that we as a community continue to scrutinize rigorously the various perfusion strategies that we use for these complex aortic arch reconstructions to optimize individual practice results, as the group from Seoul¹ has done with their study. For confirmation and broad acceptance of this technique relative to others, however, a larger and more robustly controlled randomized, controlled trial is necessary to prove that axillary artery cannulation distinctly reduces stroke and mortality relative to other widely utilized techniques.

References

1. Kim J-H, Lee SH, Lee S, Youn Y-N, Yoo K-J, Joo H-C. Axillary artery cannulation reduces early embolic stroke and mortality after open arch repair with circulatory arrest. *J Thorac Cardiovasc Surg.* 2020;159:772-8.e4.
2. Messé SR, Acker MA, Kasner SE, Fanning M, Giovannetti T, Ratcliffe SJ, et al; Determining Neurologic Outcomes from Valve Operations (DeNOVO) Investigators. Stroke after aortic valve surgery: results from a prospective cohort. *Circulation.* 2014;129:2253-61.
3. Leshnower BG, Rangaraju S, Allen JW, Stringer AY, Gleason TG, Chen EP. Deep hypothermia with retrograde cerebral perfusion versus moderate hypothermia with antegrade cerebral perfusion for arch surgery. *Ann Thorac Surg.* 2019;107:1104-10.
4. Hu Z, Wang Z, Ren Z, Wu H, Zhang M, Zhang H, et al. Similar cerebral protective effectiveness of antegrade and retrograde cerebral perfusion combined with deep hypothermia circulatory arrest in aortic arch surgery: a meta-analysis and systematic review of 5060 patients. *J Thorac Cardiovasc Surg.* 2014;148:544-60.
5. Okita Y, Minatoya K, Tagusari O, Ando M, Nagatsuka K, Kitamura S. Prospective comparative study of brain protection in total aortic arch replacement: deep hypothermic circulatory arrest with retrograde cerebral perfusion or selective antegrade cerebral perfusion. *Ann Thorac Surg.* 2001;72:72-9.
6. Okita Y, Miyata H, Motomura N, Takamoto S; Japan Cardiovascular Surgery Database Organization. A study of brain protection during total arch replacement comparing antegrade cerebral perfusion versus hypothermic circulatory arrest, with or without retrograde cerebral perfusion: analysis based on the Japan adult cardiovascular surgery database. *J Thorac Cardiovasc Surg.* 2015;149(2 Suppl):S65-73.
7. Svensson LG, Blackstone EH, Apperson-Hansen C, Ruggieri PM, Ainkaran P, Naugle RI, et al. Implications from neurologic assessment of brain protection for total arch replacement from a randomized trial. *J Thorac Cardiovasc Surg.* 2015;150:1140-7.e11.
8. Svensson LG, Nadolny EM, Penney DL, Jacobson J, Kimmel WA, Entrup MH, et al. Prospective randomized neurocognitive and S-100 study of hypothermic circulatory arrest, retrograde brain perfusion, and antegrade brain perfusion for aortic arch operations. *Ann Thorac Surg.* 2001;71:1905-12.

9. Tanoue Y, Tominaga R, Ochiai Y, Fukae K, Morita S, Kawachi Y, et al. Comparative study of retrograde and selective cerebral perfusion with transcranial Doppler. *Ann Thorac Surg.* 1999;67:672-5.
10. Usui A, Miyata H, Ueda Y, Motomura N, Takamoto S. Risk-adjusted and case-matched comparative study between antegrade and retrograde cerebral perfusion during aortic arch surgery: based on the Japan adult cardiovascular surgery database: the Japan cardiovascular surgery database organization. *Gen Thorac Cardiovasc Surg.* 2012;60:132-9.
11. Trivedi D, Navid F, Balzer JR, Joshi R, Lacomis JM, Jovin TG, et al. Aggressive aortic arch and carotid replacement strategy for type A aortic dissection improves neurologic outcomes. *Ann Thorac Surg.* 2016;101:896-903; discussion 903-5.