Total Arch Replacement and Frozen Elephant Trunk Implantation for Acute Type A Dissection Using Complete Cerebral Perfusion and Upper Hemisternotomy

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To the Editor: Aortic arch surgery for acute aortic dissection is conventionally performed through median sternotomy. To date, there have been no reports of using upper hemisternotomy to repair Type A dissection. The main concern is the safety of using a minimally invasive approach for such a high-risk surgery.[1] Here, we introduce a technique to perform a preferential reconstruction of the arch vessels with complete cerebral perfusion technique during hypothermic circulatory arrest (HCA) to improve neuroprotection.

A 46-year-old male patient was diagnosed as acute Type A aortic dissection with normal aortic valve by computed tomography aortography (CTA) and transthoracic echocardiography. The patient did not have severe preoperative morbidity. Emergency minimally invasive total arch replacement was performed on August 23, 2016.

Following induction of anesthesia, ministernotomy was performed [Figure 1a]. The innominate artery (IA), left carotid artery (LCA), and left subclavian artery (LSCA) were mobilized. After systemic heparinization, a 10-mm graft was anastomosed to the IA and connected to one line of the Y-shaped arterial inflow tube from the cardiopulmonary bypass (CPB) circuit. The right atrium was cannulated using a 34-Fr two-stage venous cannula. The left ventricular vent cannula was inserted through the right superior pulmonary vein [Figure 1b and 1c].

Before CPB was initiated, the LSCA was anastomosed to the first branch of a four-branched graft (Vascutek, Inchinnan, United Kingdom) (duration = 10 min). The other line of the Y-shaped arterial inflow tube was connected to the perfusion limb of the branched graft and then CPB was then started and blood supply to the LSCA was resumed. Cooling was initiated with a target nasopharyngeal temperature of 26°C and bladder temperature of 29°C. The LCA was then anastomosed to the second branch (duration = 6 min). After de-airing, blood supply through LCA was resumed [Figure 1d].

Then, the ascending aorta was cross-clamped and aortotomy was made. Histidine-tryptophan-ketoglutarate cardioplegic solution (Bretschneider's solution, Custodiol) was infused through the coronary ostia. The ascending aorta was transected 5 mm above the sinotubular junction, which was reinforced with the sandwich technique.

Access this article online	
Quick Response Code:	Website: www.cmj.org
	DOI: 10.4103/0366-6999.239302

When the desired temperature of hypothermia was achieved, blood flow from the pump was reduced to 10 ml·kg^{-1}·min^{-1} and the left radial arterial pressure was maintained at 50 mmHg. The aortic cross-clamp was removed, lower body HCA was initiated and complete antegrade cerebral perfusion through IA, LCA, and LSCA was performed. The arch was transected between the IA and LCA and a self-expanding stent graft (Cronus, Microport, Shanghai, China) was implanted into the distal arch, covering the orifices of the LSCA and LCA. The stump of the aorta was reinforced using the sandwich technique. The branched graft was sutured to the aortic stump followed by reperfusion of the lower body and rewarming. Then, the proximal branched graft was anastomosed to the aortic sinotubular junction and blood supply to the coronary artery was restored. Finally, the IA was anastomosed to the third branch of the graft (duration = 8 min) [Figure 1e]. When the bladder temperature returned to 35°C, the patient was weaned off CPB and given protamine was given.

The CPB time was 172 min, the cross-clamping time was 124 min and the mild HAC time was 33 min. The patient woke up 4 h after surgery and was extubated 8 h postoperatively. He recovered smoothly and was discharged home without any complications. As of his 13-month follow-up, the patient had no complications and his aorta was normal without residual false lumen according to CTA [Figure 1f].

After building experience in minimally invasive aortic root surgery and aortic dissection surgery through full median sternotomy, we cautiously selected this young and stable patient with acute aortic dissection to perform this minimally invasive surgery. The preliminary result showed that the surgical field was not cumbersome and all procedures could be performed smoothly.

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Received: 28-03-2018 **Edited by:** Li-Shao Guo

How to cite this article: Xiao CS, Li D, Ren CL, Wang G. Total Arch Replacement and Frozen Elephant Trunk Implantation for Acute Type A Dissection Using Complete Cerebral Perfusion and Upper Hemisternotomy. Chin Med J 2018;131:2130-1.

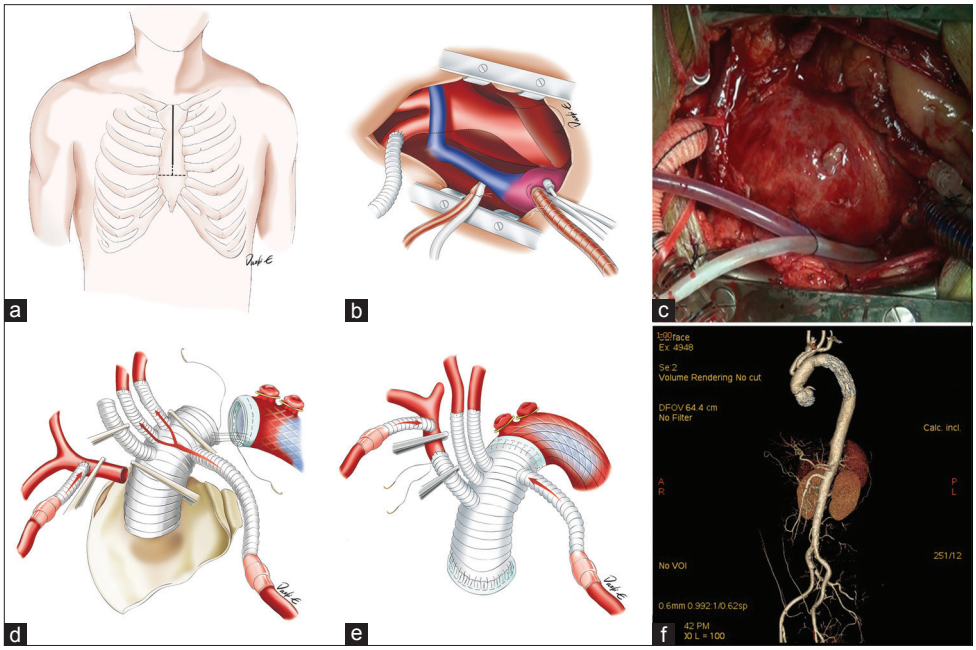

Figure 1: (a) Upper hemisternotomy. (b and c) Vignette after CPB was established. (d) LSCA and LCA were preferentially reconstructed and complete antegrade cerebral perfusion during moderate HCA was performed. (e) IA was finally reconstructed following aortic root reconstruction. (f) Thirteen months after surgery, CTA showed normal aorta without residual false lumen. CPB: Cardiopulmonary bypass; LSCA: Left subclavian artery; LCA: Left carotid artery; HCA: Hypothermic circulatory arrest; IA: Innominate artery; CTA: Computed tomography aortogram.

Open repair of acute aortic dissection involving the aortic arch has traditionally been associated with high rates of mortality and morbidity.[2] This modified technique has several advantages. First, preferentially reconstructed arch vessels were used as routes in cerebral perfusion and extra cannulation of the LCA and LSCA was eliminated.[3] The sequential anastomoses of the supra-aortic vessels may reduce CPB and HCA time compared with other technique.[4] Second, cerebral perfusion through the three supra-aortic vessels simultaneously may provide an even cerebral blood flow distribution. Therefore, deep HCA was avoided.[5] Third, this minimally invasive approach of partial sternotomy can reduce chest trauma. However, operation through hemisternotomy is technically demanding. The surgeon's experience and operative skills are crucial for the success of the procedure. Benefit of minimally invasive hemisternotomy must be balanced with operative risk. Learning cure is definitely indispensable.

Minimally invasive total arch replacement and frozen elephant trunk implantation through upper hemisternotomy is a feasible approach to treat acute Type A aortic dissection in select patients in experienced heart centers. Complete cerebral perfusion can improve neuroprotection. The outcomes need to be further verified.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that his name and initial will not be published and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. 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. doi: 10.1016/j.athoracsur.2015.08.073.
2. Berretta P, Patel HJ, Gleason TG, Sundt TM, Myrmel T, Desai N, *et al.* IRAD experience on surgical type A acute dissection patients: Results and predictors of mortality. Ann Cardiothorac Surg 2016;5:346-51. doi: 10.21037/acs.2016.05.10.
3. Shiiya N, Kunihara T, Imamura M, Murashita T, Matsui Y, Yasuda K, *et al.* Surgical management of atherosclerotic aortic arch aneurysms using selective cerebral perfusion: 7-year experience in 52 patients. Eur J Cardiothorac Surg 2000;17:266-71. doi: 10.1016/S1010-7940(00)00340-7.
4. LeMaire SA, Weldon SA, Coselli JS. Total aortic arch replacement: Current approach using the trifurcated graft technique. Ann Cardiothorac Surg 2013;2:347-52. doi: 10.3978/j.issn.2225-319X.2013.05.02.
5. Luehr M, Bachet J, Mohr FW, Etz CD. Modern temperature management in aortic arch surgery: The dilemma of moderate hypothermia. Eur J Cardiothorac Surg 2014;45:27-39. doi: 10.1093/ejcts/ezt154.