Three-vessel anastomosis for direct bihemispheric cerebral revascularization


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Introduction

- Open surgical revascularization is the mainstay treatment for moyamoya and complex aneurysms unamenable to conventional approaches\textsuperscript{1-2}
- In rare, select cases revascularization of multiple vascular territories may be necessary\textsuperscript{3-4}
- Multi-territory bypass strategies often require more than one interposition graft, multiple craniotomies and anastomoses, vessel reimplantations or other complex constructs\textsuperscript{1-2,5}
- In this report we describe a novel three-vessel anastomosis technique which combines a side-to-side and an end-to-side anastomosis to simultaneously, directly revascularize two vascular territories using a single graft vessel

\textsuperscript{1}Natarajan et al., World Neurosurg, 2019
\textsuperscript{2}Lawton and Lang, J Neurosurg, 2019
\textsuperscript{3}Esposito et al., Childs Nerv Syst, 2015
\textsuperscript{4}Egashira et al., World Neurosurg 2018
\textsuperscript{5}Benet et al., Oper Neurosurg 2018
Methods – case presentation

• A 53 y/o man presented with an acute stroke in right MCA and smaller watershed punctate strokes in b/l ACA and MCA territories (A)
  • **CT perfusion:** Increased Tmax (B), decreased CBF and BV in right MCA territory
  • **CTA:** diffuse narrowing of b/l ICAs (worse on right), complete occlusion of right MCA M1
  • **Catheter angiogram:** moyamoya-like vasculature, severe stenosis of b/l ACA A1 segments, no anterograde filling of left ACA beyond A1 (C-D)

• Consensus: the patient would benefit of indirect revascularization of right MCA and direct revascularization of bilateral ACA territories

• STA-radial artery flow-through free flap (RAFF)-ACA-ACA bypass strategy was planned
Results – surgical strategy

- Benefits of selecting RAFF in presented case:
  - Both, direct and indirect revascularization sources are available (direct – ACA territories, indirect – MCA territory with acute stroke for long-term benefit)
  - Sufficient length to reach into the interhemispheric fissure
  - A three-vessel anastomosis between the distal end of radial artery graft and b/l ACA A3 segments was planned to simultaneously directly revascularize b/l ACA territories
Results – three-vessel anastomosis (1)

1. A 10-0 nylon suture is used to anastomose back walls of bilateral ACA A3s in a running fashion (A)

2. Last suture throw at the distal end of the arteriotomy is made from the inside to the outside of the right artery and then from the outside to the inside of the left artery. Then the needle is once again passed from the inside to the outside of the left artery (B)

3. Then needle is passed back from the outside to the inside of the right artery and again from the inside to the outside of the left artery leaving the loop untightened (C) to make a knot (D)

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Results – *three-vessel anastomosis (2)*

4. Proximal and distal anchor suture knots are placed connecting the distal end of the graft with both A3s, each on the opposite side of the side-to-side construct going in opposite directions (E)

5. The proximal anchor suture is run to connect graft and the anterior wall of the right artery and a knot tied at the end (F)

6. Distal anchor suture is run in the opposite direction and a knot tied at the end (G) completing the anastomosis (H)
Results – outcome

- Catheter angiogram on post-operative day 5 demonstrated patency of the three-vessel anastomosis and filling in bilateral distal ACAs through the bypass (arrow)
- The right ACA is visible just distal to the bypass secondary to washout from preserved anterograde flow in that ACA (black arrowhead)
- The entirety of the left ACA is visible given the lack of anterograde flow in that vessel prior to the bypass (white arrowhead)
- CT demonstrated no new ischemia and the patient’s left sided weakness improved
Discussion

• As the complexity of cases referred for open surgical treatment increases, there remains an ongoing need to advance and optimize surgical techniques\(^1\)\(^-\)\(^3\)

• Presented novel anastomosis may be especially useful for moyamoya treatment given that it commonly affects multiple vascular territories and complex aneurysms which incorporate multiple major arterial branches\(^2\),\(^4\)

• This anastomotic construct is technically challenging and potentially subjects both recipient vascular territories to ischemia risk. These risks are similar to any traditional side-to-side *in situ* bypass\(^5\)

• In case of technical failure, a bailout strategy of completing separate side-to-side and end-to-side anastomoses is viable

\(^1\)Lawton and Lang, *J Neurosurg*, 2019
\(^2\)Kalani et al., *Neurosurgery*, 2014
\(^3\)Davies and Lawton, *Neurosurgery*, 2014
\(^4\)Egashira et al., *World Neurosurg*, 2018
\(^5\)Wang et al., *World Neurosurg*, 2018
Summary points

• This report demonstrates the feasibility of a novel three-vessel anastomosis for direct simultaneous two arterial territory revascularization

• This technique has potential utility in both flow replacement and flow augmentation strategies

• This single-stage strategy combining side-to-side and end-to-side techniques has benefits over traditional revascularization techniques:
  • It is not deconstructive
  • It requires only a single craniotomy and a single interposition graft
  • It does not require lengthy recipient artery dissection