

# Flow-Assisted Surgical Techniques and Notes\*

## STA-MCA Bypass for Moyamoya Protocol

\*Flow-Assisted Surgical Techniques ("F•A•S•T") and Protocols are drawn from surgical experiences by transit-time flow measurement users and passed along by Transonic for educational purposes. They are not intended to be used as the sole basis for diagnosis. Clinical interpretation of each patient's individual case is required.

### Introduction<sup>1,3</sup>

One strategy a surgeon may elect to use to alleviate the symptoms of Moyamoya syndrome is the surgical creation of an arterial extracranial to intracranial (EC-IC) bypass from the superficial temporal artery (STA) to the cerebral artery branches. The bypass is designed to augment flow in the intracranial territories. During surgery, the Charbel Micro-Flowprobe® is used to measure direct volume blood flow in the STA bypass and small target MCA branch vessels. Intraoperative blood flow measurements confirm the quality of the anastomosis and assure that the target area is receiving sufficient blood from the bypass. Measurements also prompt revision if a technical error is suspected.

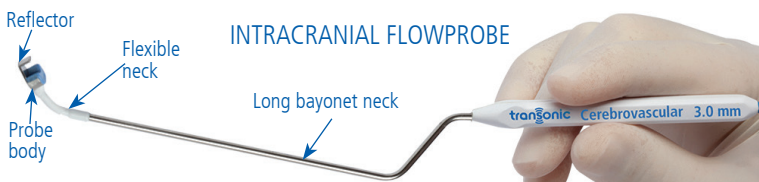
### Flow Measurement Steps<sup>1,2</sup>

Measure mean arterial pressure (MAP), end-tidal CO<sub>2</sub> and temperature. Record values on an Bypass Flow Record.

### Pre-anastomosis: Intracranial Recipient Arteries

1. Measure the diameter of the intracranial recipient arteries and choose appropriately-sized Charbel Micro-Flowprobes to measure recipient vessel flows.

PROBE SIZE	VESSEL RANGE, OUTER DIAMETER
1.5 mm	1.1 - 1.6 mm
2 mm	1.6 - 2.4 mm



2. Measure recipient vessels (M4branches/MCA) flow.
3. Record flow and flow direction on EC-IC Bypass Record.

### Extracranial Donor Artery<sup>1,2</sup>

4. Dissect the extracranial STA artery free. Skeletonize a segment for application of the Flowprobe.
5. Measure the diameter of the STA and choose the appropriately-sized Flowprobe to measure STA baseline flow. See table above for probe sizes.

### Post-anastomotic Flow Measurements

6. After construction of a one donor artery (STA) to two recipient arteries (M4 branches/MCA) with a side-to-side and an end-to-side anastomoses (1D2R) bypass<sup>3,4</sup>, measure post-anastomotic flows in the intracranial and extracranial arteries sequentially in the following order:
  - 1) distal M4 branch/MCA;
  - 2) proximal M4 branch/MCA;
  - 3) distal STA;
  - 4) proximal STA.
7. If post-bypass flow in the recipient arteries (sum of absolute values of distal and proximal M4/MCA recipient flows) is not significantly above the pre-bypass flow, re-examine the anastomoses and the bypass for kinks or twists and redo, if necessary. Apply a vasodilator (papaverine) when there is vasospasm due to manipulation of the vessel and/or if flow measurements seem to be low or absent.
8. Record flow rates and flow directions, MAP, end-tidal CO<sub>2</sub>, and occlusion time on the EC-IC Bypass Record.

### References:

- 1 Cerebrovascular Surgery Handbook NS-59-hb, Rev G, 2021.
- 2 Measuring PeriFlowprobe (CV-180-mn) Rev A 2018.
- 3 Khan NR, Morcos JJ. *et al*, One-donor, two-recipient extracranial-intracranial bypass series for moyamoya and cerebral occlusive disease: rationale, clinical and angiographic outcomes, and intraoperative blood flow analysis. *J Neurosurg.* 2021 Aug 20:1-10. (Transonic Reference # NS2021-30AH)
- 4 Arnone GD, Hage ZA, Charbel FT. Single Vessel Double Anastomosis for Flow Augmentation - A Novel Technique for Direct Extracranial to Intracranial Bypass Surgery. *Oper Neurosurg (Hagerstown).* 2019 Oct 1;17(4):365-375. PMID: 30690506. (Transonic Reference # NS2019-30AH)
- 5 Lee M *et al*, "Intraoperative blood flow analysis of direct revascularization in patients with moyamoya disease," *J Cereb Blood Flow & Metab* 2011; 31(1):262-74. (Transonic Reference # 7969AH)
- 6 Guzman R, Steinberg GK, "Direct bypass techniques for the treatment of pediatric moyamoya disease," *Neurosurg Clin N Am.* 2010 Jul; 21(3): 565-73. (Transonic Reference # 8010AH).
- 7 Amin-Hanjani S, Charbel FT *et al*, "Combined Direct and Indirect Bypass for Moyamoya: Quantitative Assessment of Direct Bypass Flow Over Time," *Neurosurgery* 2013; 73(6): 962-8. (Transonic Reference # 9835AH)

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## STA-MCA Bypass for Moyamoya Protocol cont.

### Flow Measurement during EC-IC Bypass Revascularization for Moyamoya Syndrome<sup>1-4</sup>

Measure size of recipient intracranial arteries (M4 branches/  
MCA) and choose appropriate size Flowprobe(s).

Measure baseline flow of recipient intracranial arteries (M4  
branches/MCA) at anastomotic site. Record flow.

Measure size of donor artery (STA) at distal end and  
choose appropriate-size Flowprobe.

Cut donor STA.

Optional: measure/record free (cut) flow in donor STA.

Construct EC-IC bypass by anastomosing donor STA to two M4 branches of the  
MCA. The proximal M4 branch is anastomosed with a side-by-side anastomosis.  
The distal M4 branch is anastomosed with an end-to-side anastomosis.

Measure post-bypass flows proximal and distal to the  
anastomoses in the recipient vessels and donor STA.  
Record all flow rates.

**M4 flows did  
not increase**

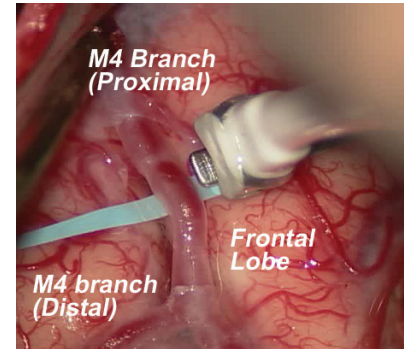
Examine anastomoses;  
examine bypass for kinks  
etc. Analyze recipient beds.

**M4 flows  
increased**

Good  
bypass.

**M4 flows  
increased  
significantly**

Aggressive post-op  
management indicated  
to avoid complications.



*Photo shows the M4/MCA site just before the Flowprobe is slipped around the vessel to measure baseline M4 flow before anastomosing the bypass to the vessel. The blue background is placed to help visibility during sewing of the anastomosis and as the Flowprobe is applied to the vessel.*