Flow-assisted Surgical Techniques and Notes* Arterial EC-IC Bypass Surgery Protocol

Drawn from the clinical expertise of FT Charbel, MD, FACS, S Amin-Hanjani, Univ. of IL at Chicago, Chicago, IL *et al.*[1-24]

*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 sole basis for diagnosis. Clinical interpretation of each patient's individual case is required.

Introduction[3]

An extracranial to intracranial (EC-IC) bypass is used during cerebrovascular surgery:

1) to augment flow for occlusive cerebrovascular disease (i.e., Moyamoya)
2) to replace flow during aneurysm clipping surgery when an aneurysm is trapped and a parent vessel (i.e., internal carotid) has to be occluded and sacrificed.

Flow Augmentation for Occlusive Cerebrovascular Disease[1-5]

In 2005, Drs. Fady Charbel and Sepideh Amin-Hanjani introduced the concept of a Cut Flow Index to evaluate the quality of an EC-IC bypass used to enhance flow during cerebral ischemia. Briefly, the free flow of the donor extracranial artery intended for use as a bypass is measured. Once the bypass is constructed, the bypass flow of the donor artery is measured. The ratio of bypass flow to free flow is the Cut Flow Index. A value greater than 0.5 indicates that the bypass should be viable.

Flow Replacement during Aneurysm Clipping Surgery[1,6]

Dr. Amin-Hanjani developed a strategy to assess the adequacy of an STA-or an occipital artery bypass to replace flow when an aneurysm has to be trapped and a parent vessel sacrificed.

Flow Deficit Determined

Flow in the artery or territory distal to the aneurysm is measured and recorded. The vessel to be sacrificed is temporarily occluded and flow is again measured in the distal artery or territory. The difference between the two flows represents the amount of flow deficit that can be expected if the parent vessel is sacrificed. This is the flow that the bypass will have to replace.

Free Flow Determined

The "Free" or "Cut Flow" of the intended bypass is then measured. This Cut Flow value is compared to Deficit Flow. If the Cut Flow value equals or exceeds the potential flow deficit, the EC-IC bypass is completed and the vessel can be sacrificed with reasonable assurance that the bypass flow will compensate for the flow deficit from the sacrificed parent vessel.

Example: STA to M3 Bypass (ICA Aneurysm Clipped, Trapped and ICA Sacrificed)[1,6]

1)	M1 baseline flow measured	70mL/min
2)	M1 flow measured with ICA temporarily occluded	50 mL/min
3)	Anticipated Flow Deficit Calculated (if aneurysm trapped and parent vessel sacrificed)	20 mL/min
4)	STA Cut Flow measured (STA bypass should be able to supply the flow deficit)	44 mL/min
5)	STA Bypass to M3 completed; aneurysm clipped and trapped	
6)	STA Bypass Graft Flow measured (bypass flow can compensate for anticipated flow deficit)	24 mL/min

Dr. Amin-Hanjani reported that this selective strategy allows the surgeon to:

1) Assess the adequacy of a bypass before completing its construction
2) Select the best match for a bypass
3) Evaluate the bypass immediately

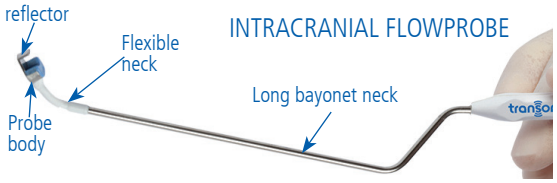
Flow-assisted Surgical Techniques and Notes
Arterial EC-IC Bypass Surgery Protocol cont.

When a surgeon selects an arterial extracranial-intracranial (EC-IC) Bypass to preserve flow during aneurysm clipping or trapping surgery, Charbel Probes® assess the adequacy of flow(s) during and after construction of the bypass.[1-5]

Extracranial Donor Artery[1-7]

1. Choose an appropriate-sized Charbel Probe® for the donor (STA) artery.

Probe Size	Vessel Range, Outer Diameter
1.5 mm	1.1 - 1.6 mm
2 mm	1.6 - 2.4 mm
3 mm	2.6 - 3.8 mm



2. Measure baseline flow in the donor artery. Record on the EC-IC Bypass Record.
3. Cut the donor extracranial artery and measure the artery's "Free Flow" by allowing the cut distal end to bleed freely for 15-20 seconds (Fig. 1). This free flow or "Cut Flow"is the amount of flow at zero resistance or the "carrying" capacity or maximum flow the artery can deliver. Record flow on the EC-IC Bypass Record.[5]

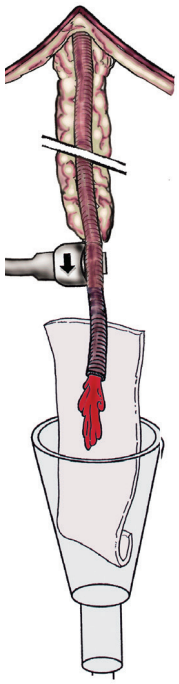
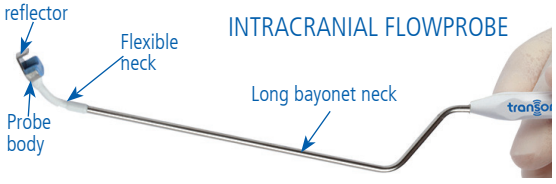


Fig. 1: Measurement of "cut" flow in donor artery.

Intracranial Recipient Artery[1-7]

1. Choose an appropriate size Charbel Probe® for recipient artery.

Probe Size	Vessel Range, Outer Diameter
1.5 mm	1.1 - 1.6 mm
2 mm	1.6 - 2.4 mm
3 mm	2.6 - 3.8 mm



2. Measure and record baseline flow in recipient intracranial artery distal to target anastomotic site.
3. Re-measure, record baseline flow in recipient intracranial artery distal to target anastomotic site with vessel to be sacrificed occluded.
4. Calculate anticipated flow deficit by substracting flow with vessel occluded from baseline recipient arterial flow.

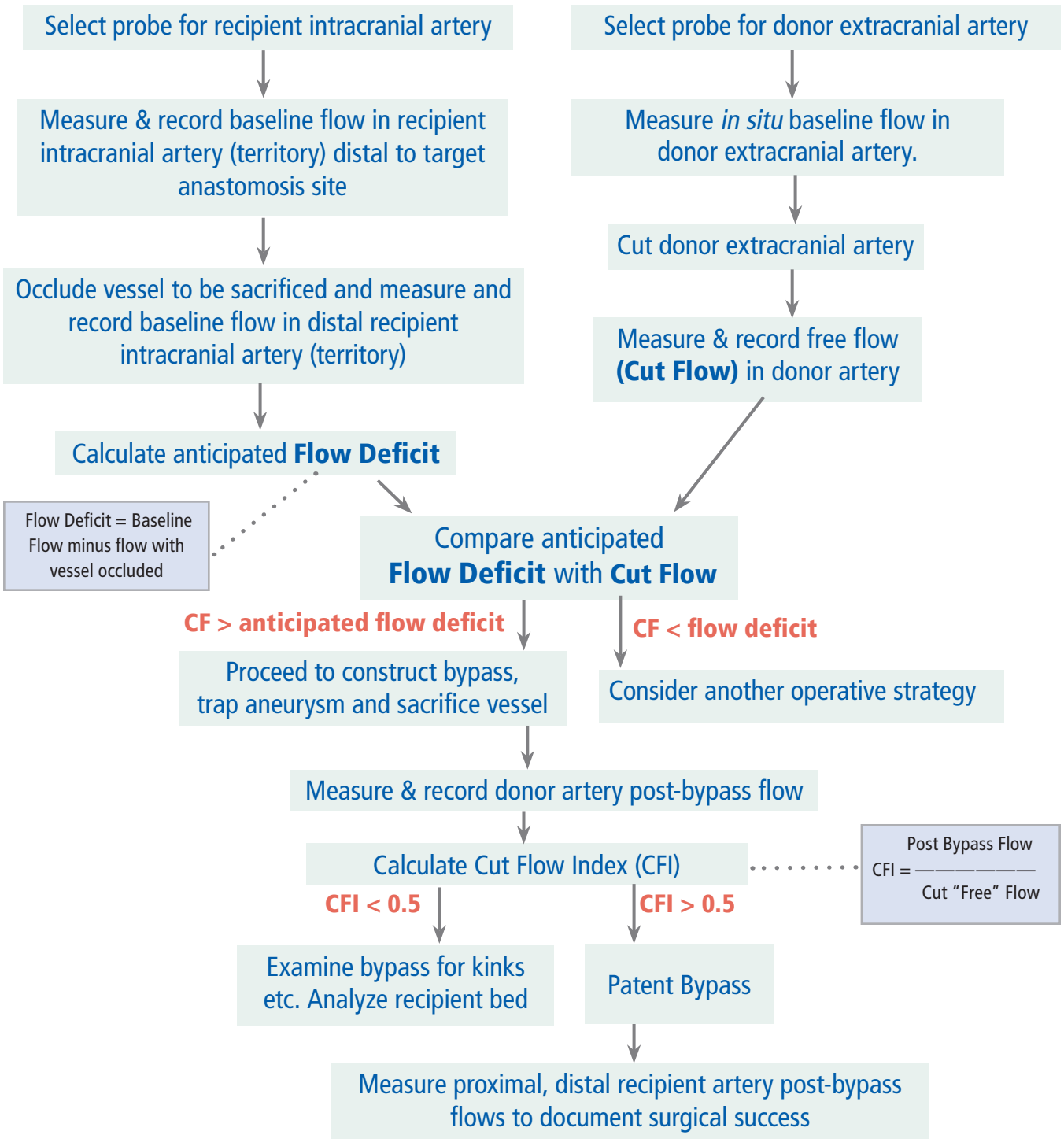
Fig. 2: Flow measurement of bypass after anastomosis to recipient artery.

Construct EC-IC Bypass[1-7]

1. Anastomose the extracranial bypass to the recipient arterial vessel.
2. Measure post-bypass flow in the donor artery (Fig. 2). Record flow.
3. Calculate the Cut Flow Index (CFI) by dividing the Post-Bypass Flow by the Free or Cut Flow (Fig. 1).
   - If post-bypass flow exceeds 50% of (CFI > 0.5), the bypass can be considered successful.
   - If bypass flow is below 50% of free flow (CFI < 0.5), examine bypass for kinks, analyze recipient bed.

Flow-assisted Surgical Techniques and Notes
Arterial EC-IC Bypass Surgery Protocol cont.

EC-IC Bypass for Aneurysm Clipping and Trapping Surgey[1-7]



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