Flow-assisted Surgical Techniques and Notes*
Aneurysm Clipping Surgery Protocol

Drawn from the clinical expertise of FT Charbel, MD, S Amin-Hanjani MD, Univ. of IL at Chicago

*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[1,4-9]

During aneurysm clipping surgery, a cerebrovascular surgeon may elect to use a non-constrictive Charbel Micro-Flowprobe® to measure blood flow in major cerebral vessels. Flow measurements help the surgeon achieve optimal clip placement to obliterate the aneurysm without compromising flow in parent vessels and distal branches that might cause an intraoperative stroke.

Measurements Steps[1-4]

1. Identify Vessels at Risk

Expose and identify parent vessels and distal outflow vessels of the aneurysm.

2. Select Flowprobe Size

Measure the vessel diameter of the target vessels with a gauge before opening the Probe package. Select Probe size(s) so that the vessel(s) will fill between 75% - 100% of the window of the Probe(s).

3. Apply Flowprobe

Examine the vessel to determine the optimal position for applying the Probe. Select a site wide enough to accommodate the Probe's acoustic reflector without compromising perforating arteries coming off the vessel. Apply the Flowprobe so that the entire vessel lies within the Probe window and aligns with the Probe body.

Bend the Flowprobe's flexible neck as needed to position the Probe on the vessel. As the Flowprobe is being applied to the vessel, listen to FlowSound®. The higher the pitch, the greater the flow.

Sterile saline or cerebrospinal fluid may be used to flood the Probe window and provide ultrasound coupling. Do not irrigate continuously because the Probe will also measure the flow of the saline. Check the Signal Quality Indicator on the Flowmeter for adequate acoustic contact. If acoustic contact falls below an acceptable minimum, the Flowmeter/monitor displays an acoustic error message.

4. Measure Baseline Flows

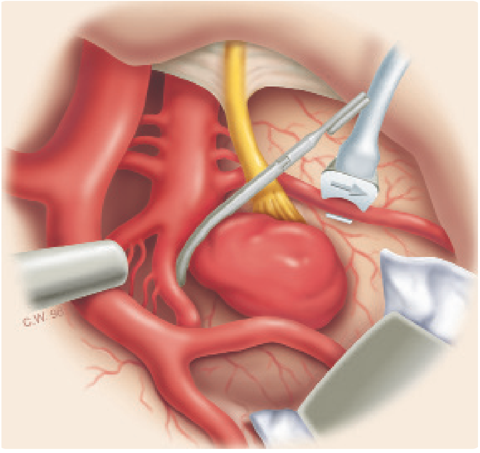
Measure baseline flows in all vessels at risk before clipping the aneurysm. Baseline flows should be measured following burst suppression, since these protective agents will decrease baseline flows. Record the baseline flow measurements and the patient's blood pressure on the Flow Record.

5. Document Flows

Wait 10-15 seconds for mean readings to stabilize after applying the Probe. Document flows for the case record by recording them, printing or taking a snapshot of the phasic flows. If the meter displays a negative flow, press the INVERT button to change the polarity before printing the waveform.

6. Post-Clip Flows & Compare to Baseline

After an aneurysm has been clipped, remeasure flow in each of the vessels and compare the post-clip flows with baseline flows. Each measurement should be equal or greater than the respective baseline flow. Greater flows are expected in cases where the aneurysm has compromised flow well below the vessel's expected flow level (chart on page 4). Temporary clipping can also produce hyperemia which can cause flows to be 20-30% higher than baseline.



RIGHT SUPERIOR CEREBELLAR ANEURYSM with Flowprobe placed on superior cerebellar artery (SCA) to measure restoration of flow after clipping the aneurysm. Illustration by Christa Wellman

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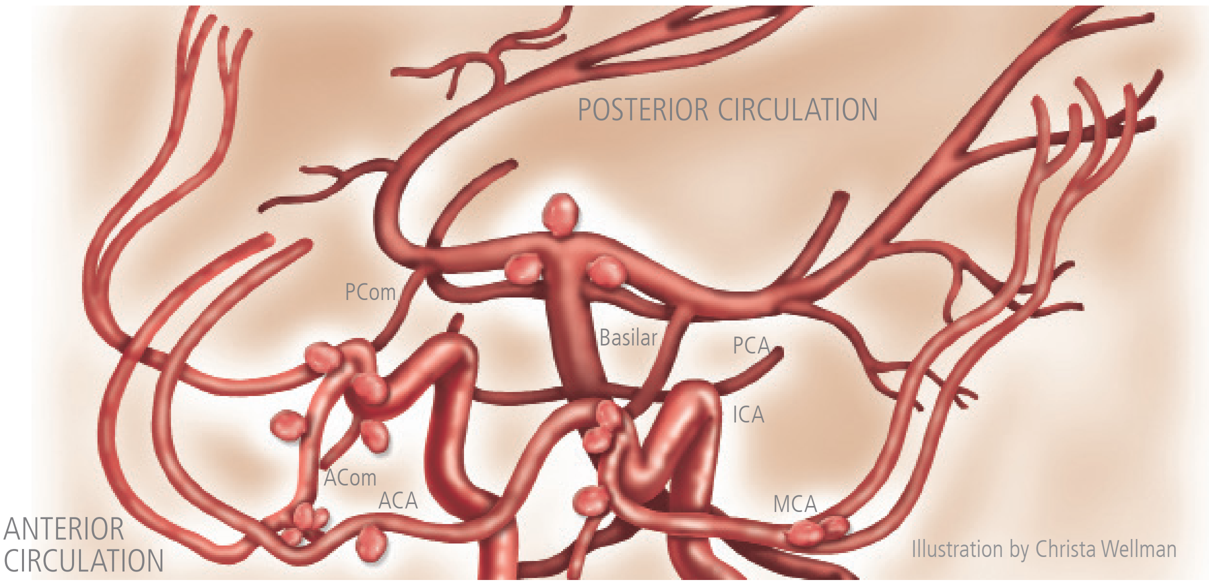

Common sites for anterior circulation aneurysms include the carotid ophthalmic artery (OpthA), Internal Carotid Artery (ICA) bifurcation, Middle Cerebral Artery (MCA) bifurcation, M1 Segment MCA, Anterior Cerebral Communicating Artery (AComA), and Posterior Communicating Artery (PComA) artery. The most common sites for aneurysms in the posterior cerebral circulation include the basilar artery (BA), posterior inferior cerebellar artery (PICA) and superior cerebellar artery (SCA).

Measuring Flow[1]

Identify Vessels at Risk

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Select Proper Flowprobe Size

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Measure Baseline Flows
in all vessels at risk

↓

Measure Post-clip Flows
in all vessels at risk

↓

Compare Post-clip Flows
to Baseline Flow

Flow equal or more than baseline → Flow Preserved in vessels at risk

Flow less than baseline → Re-examine/adjust clip and remeasure flow.

Flow Measurement Summary[1-3]

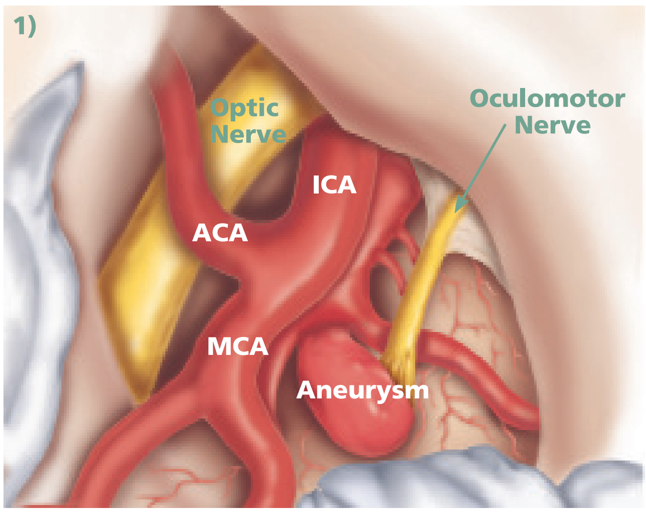
- Measure vessel and select a Flowprobe size so that the vessel will fill at least 75% of the Flowprobe's lumen. Use sterile saline or cerebrospinal fluid to obtain good ultrasonic contact between the Flowprobe and the vessel.
- Bend the Flowprobe's flexible segment to best position the probe around the vessel. Listen to FlowSound® to hear volume flow.
- When readings stabilize, capture flow data by recording, taking a snapshot, or by pressing PRINT on the Flowmeter. If the Flowmeter's LED flow reading is negative, press INVERT to reverse the polarity of the flow reading from negative to positive before printing out the waveform.

Measurement Review[1]

- Measure baseline flows before clipping aneurysm.
- Measure flow after temporary clipping of an aneurysm to check integrity of flow.
- Confirm flow restoration after permanent clipping by comparing post-clipping flows with baseline flows.

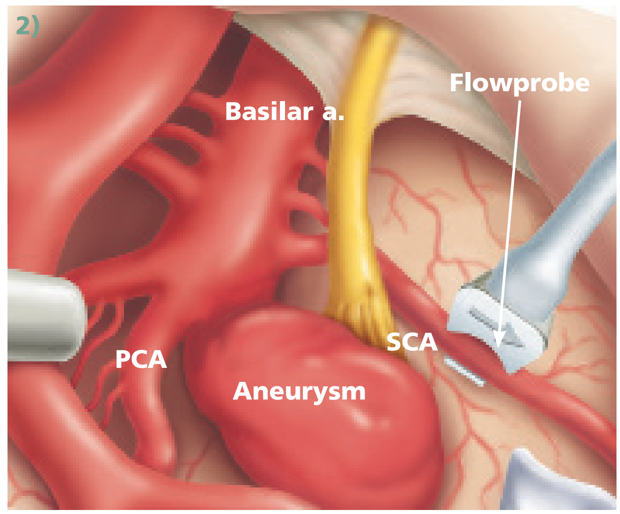
Case Report: Flow Measurement during SCA Aneurysm Clipping Surgery[1]

Illustrations by Christa Wellman

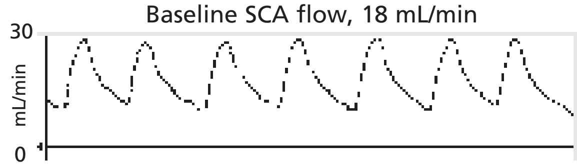


Vessel(s) at Risk Identified

A patient presented with headaches and diplopia. A cerebral angiogram confirmed a right cerebellar aneurysm. Meticulous dissection on the right side exposed an aneurysm between the superior cerebellar artery (SCA) and posterior cerebral artery (PCA).

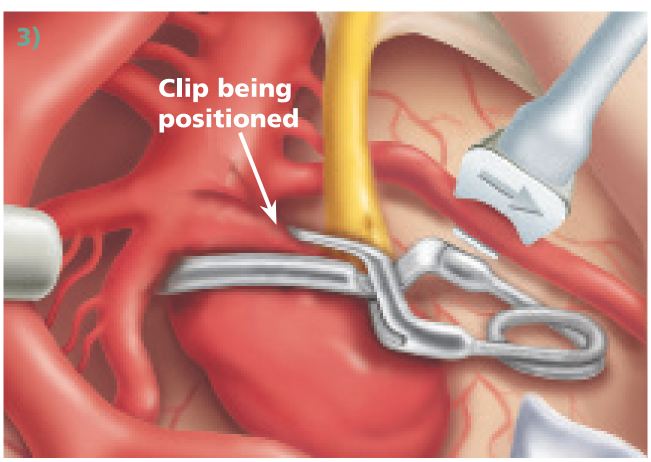


Baseline SCA flow, 18 mL/min

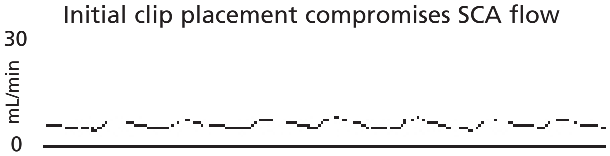


Baseline Flow Measurements

The Charbel Micro-Flowprobe® was first placed on the SCA. Flow measured 6-18 cc/min. The Flowprobe was then placed on the PCA and flow measured 34-36 cc/min.

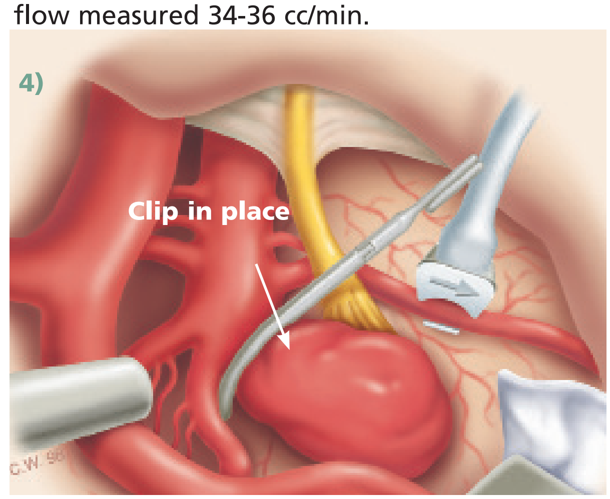


Initial clip placement compromises SCA flow

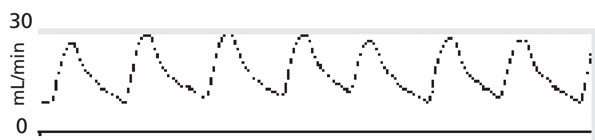


Flow Integrity Checked after Aneurysm clipping

SCA flow dropped to 2-4 cc/min.
PCA flow was recorded as 55-60 cc/min



Clip repositioned: SCA flow restored to baseline



The SCA was found to be partially incorporated in the clip. Clip repositioned and SCA and PCA flows returned almost to baseline levels.

Flow-assisted Surgical Techniques & Notes cont.*

TECHNICAL RECOMMENDATIONS: ANEURYSM SURGERY COURTESY of FT Charbel MD, FACS[1]				
Aneurysm Site	Probe Placement	Size mm	Expected Flows* ml/min	Tips
Carotid Ophthaimic A (Opth)	M1	2.0	80-110 and/or	Usually large aneurysms with no proximal control. Flow must be preserved in the the ICA and M1 and A1 outlet vessels.
	A1	2.0	40-60	
	ICA	3.0	120-170	
Posterior Communicating A (PCom)	M1	2.0	80-110 and/or	Usually large aneurysms with no proximal control. Flow must be preserved in the the ICA and M1 and A1 outlet vessels.
	A1	2.0	40-60	
	ICA	3.0	120-170	
Anterior Choroidal A (ACh)	M1	2.0	80-110 and/or	Flow in the anterior choroidal is particularly important. The 1.5 mm probe is good for this vessel.
	A1	2.0	40-60	
	ICA	3.0	120-170	
	AChA	1.5	20-60	
Carotid Bifurcation (ICA)	M1	2.0	80-110 and/or	The technical challenge is to preserve flow in the M1 and A1 outlet vessels. Flow in the ICA (3 mm) can be checked also.
	A1	2.0	40-60	
Anterior Communicating A (ACom)	A1 (ipsilateral)	2.0	40-60	High risk. The technical challenge is to preserve flow in the A2 outlet vessels. No change in both A2s indicates flow is fully preserved. One A1 usually predominates and feeds both vessels.
	A1 (contralateral)	2.0	40-60	
	A2 (both)	1.5	40-50	
Middle Cerebral A (MCA)	M2 (outlet)	2.0	50-80	This is a straightforward, relatively low stress case for the surgeon. One of the easiest places to apply the probe.
Post. Inferior Cerebellar A (PICA)	VA	3.0	100-200 and	Check flow in proximal or distal VA and PICA.
	PICA	2.0	10-15	
Superior Cerebellar A (SCA)	SCA (ipsilateral)	1.5	18-20 and	Check flow in ipsilateral SCA and PCA (Posterior Cerebral Artery).
	PCA	2.0	26-30	
Basilar Tip A (BA)	P2 (ipsilateral)	2.0	26-30 and	The perforators will still need to be inspected.
	SCA	1.5	18-20	
	PCom (prelude to sacrifice)			

References:

1. Cerebrovascular Surgery Handbook NS-59-hb, Rev F, 2018
2 Measuring PeriFlowprobe(CV-180-mn) RevA2018USltr
3 AU-QRG-Optima-EN Rev E
4.Amin-Hanjani S, Charbel FT *et al,* "The Utility of Intraoperative Blood Flow Measurements in Aneurysm Surgery Using an Ultrasonic Perivascular Flow Probe," Neurosurgery 2006; 58: 305-12. (Transonic Reference # 7226AH)
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7. Scienza R *et al,* "Flow-assisted Aneurysm Clipping. A Cooperative Study," The Proceedings of the 12th European Congress of Neurosurgery (EANS) 2003; 309-314. (Transonic Reference # 2909AH)
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9 Nakayama N *et al,* "Intraoperative Measurement of Arterial Blood Flow Using a Transit Time Flowmeter: Monitoring of Hemodynamic Changes during Cerebrovascular Surgery," Acta Neurochir 2001; 143(1): 7-24. (Transonic Reference # 1831AH)