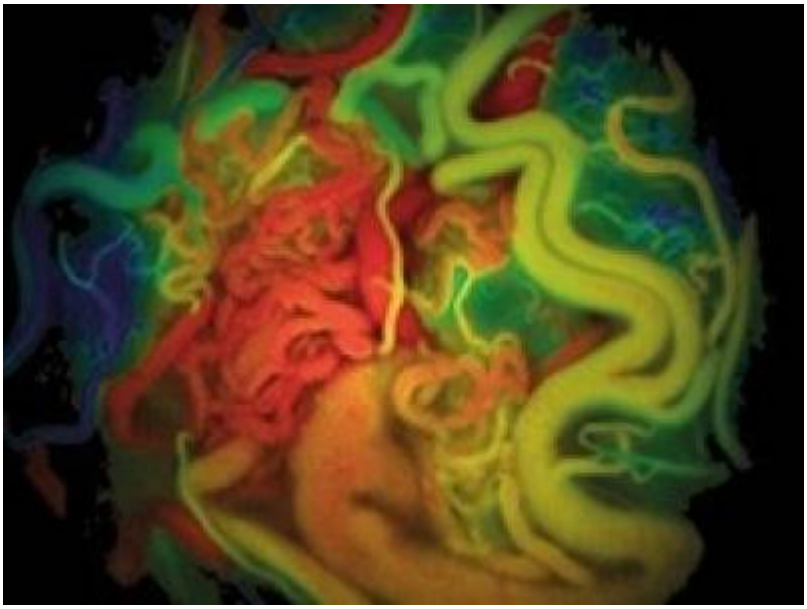
Flow 800



FLOW 800 is a surgical microscope-integrated software program that displays the cerebral blood flow in color-coded maps, thus providing semi-quantitative and real-time analysis of ICG data.

Indocyanine green (ICG) video angiography (VAG) is an established method for assessment of cerebral blood flow during microsurgical clipping of intracranial aneurysms.

Indications

This process helps identify early arterialized veins and their flow status during AVM and dAVF surgery and can confirm adequate relative flow within branching vessels during aneurysm surgery when clip-induced stenosis is suspected [1].

Although its role is limited in deep-seated AVMs, if properly dissected and exposed it can give useful information which can be easily interpretable and reproducible [2].

Rennert RC, Strickland BA, Ravina K, Bakhsheshian J, Fredrickson V, Carey J, Russin JJ. Intraoperative Assessment of Cortical Perfusion After Intracranial-To-Intracranial and Extracranial-To-Intracranial Bypass for Complex Cerebral Aneurysms Using Flow 800. Oper Neurosurg (Hagerstown). 2019 May 1;16(5):583-592. doi: 10.1093/ons/opy154. PubMed PMID: 29897545.

Cerebral hyperperfusion syndrome (CHS) is a common complication after direct bypass surgery in patients with Moyamoya disease (MMD). Since preventive measures may be inadequate, Yang et al. assessed whether the blood flow difference between the superficial temporal artery (STA) and recipient vessels (△BF) and the direct perfusion range (DPR) are related to CHS.

They measured blood flow in the STA and recipient blood vessels before bypass surgery by transit-time probe to calculate △BF. Perfusion changes around the anastomosis before and after bypass were analyzed with FLOW 800 to obtain DPR. Multiple factors, such as △BF, DPR, and postoperative CHS, were analyzed using binary logistic regression.

Results: Forty-one patients with MMD who underwent direct bypass surgery were included in the study. Postoperative CHS symptoms occurred in 13/41 patients. △BF and DPR significantly differed between the CHS and non-CHS groups. The optimal receiver operating characteristic (ROC) curve cut-off value was 31.4 ml/min for ΔBF, and the area under the ROC curve (AUC) was 0.695 (sensitivity 0.846, specificity 0.500). The optimal cut-off value was 3.5 cm for DPR, and the AUC was 0.702 (sensitivity 0.615, specificity 0.750).

Postoperative CHS is caused by multiple factors. △BF is a risk factor for CHS while DPR is a protective factor against CHS [3].

Videos

<html><iframe width="560" height="315" src="https://www.youtube.com/embed/RxNDLjk8PKc" frameborder="0" allow="accelerometer; autoplay; encrypted-media; gyroscope; picture-in-picture" allowfullscreen></iframe></html>

Case series

Goertz et al. retrospectively reviewed 54 patients (mean age: 53.6 ± 11.6 years) that underwent microsurgical clipping for 60 aneurysms and intraoperative evaluation of ICG fluorescence dynamics using FLOW 800 color coded maps. FLOW 800 data were correlated with patient characteristics, clinical outcomes and intraoperative decision-making.

There were no significant differences in FLOW 800 data between ruptured and unruptured aneurysms ($p>0.05$). Likewise, the hemodynamic parameters were not significantly different before and after definite clip placement ($p>0.05$). However, in two cases, analysis of transit times by FLOW 800 analysis revealed a hemodynamically significant clip stenosis that might have been missed by conventional ICG-VAG and resulted in adjustment of the clip position. Overall, there was one cerebral infarction, which was not related to clip placement.

FLOW 800 is a useful adjunct to ICG-VAG for intraoperative assessment of cerebral perfusion and may help to identify hemodynamically relevant clip stenosis. The beneficial impact of FLOW 800 on clinical outcome after microsurgical clipping needs to be confirmed by comparative studies [4].

Shah et al. retrospectively reviewed 23 consecutive patients for whom FLOW 800 ICG videoangiography was used. They harbored aneurysms, arteriovenous malformations (AVMs), dural arteriovenous fistula (dAVF), or hemangioblastoma. Patients' characteristics, FLOW 800 data, and clinical findings were recorded. Color map data were readily available intraoperatively and guided surgery.

The cohort included 10 patients with AVMs, 11 with aneurysms, 1 with dAVF, and 1 with

hemangioblastoma. Approximately two thirds of patients underwent intraoperative angiography. FLOW 800 data provided semiquantitative data regarding localization, flow status in major feeding arteries, and dominance of the arterialized draining veins for AVMs, more than data from ICG videoangiography alone. For complex aneurysms, color maps confirmed relative adequate flow in parent and branching vessels. For the foramen magnum dAVF, the location of the dominant transdural connection was appreciated only via flow analysis. Flow analysis created the blood flow map of a large complex solid brainstem hemangioblastoma and guided devascularization. All FLOW 800 findings agreed with intraoperative and postoperative angiography.

ICG videoangiography with FLOW 800 analysis can provide semiquantitative and relative flow magnitude data that are efficient and noninvasive. This process helps identify early arterialized veins and their flow status during AVM and dAVF surgery and can confirm adequate relative flow within branching vessels during aneurysm surgery when clip-induced stenosis is suspected [5].

References

[1] [5]
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Yang D, Zhang X, Tan C, Han Z, Su Y, Duan R, Shi G, Shao J, Cao P, He S, Wang R. Intraoperative transit-time ultrasonography combined with FLOW800 predicts the occurrence of cerebral hyperperfusion syndrome after direct revascularization of Moyamoya disease: a preliminary study. Acta Neurochir (Wien). 2020 Oct 2. doi: 10.1007/s00701-020-04599-w. Epub ahead of print. PMID: 33006072.

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