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Classification of Extracranial-Intracranial Bypass Flow by Near-Infrared Indocyanine Green Fluorescence Videoangiography and Evaluation of Graft Patency

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Introduction

Indocyanine green (ICG) videoangiography has been previously established as a non-invasive technique to gauge patency of a bypass graft. However, altered flow through the bypass graft may directly cause delayed graft occlusion. Here we report on 3 types of flow that were observed through cerebrovascular revascularization procedures.

Methods

Between February 2009 and September 2013, 48 bypass procedures were performed. Excluded from analysis were those cases in which ICG videoangiography was not performed during surgery and/or in which angiography or CT angiography was not done within 24-72 hours after surgery. After anastomosis, bypass patency was assessed first using a noninvasive technique and then with ICG videoangiography, and flow through the graft was characterized.

Results

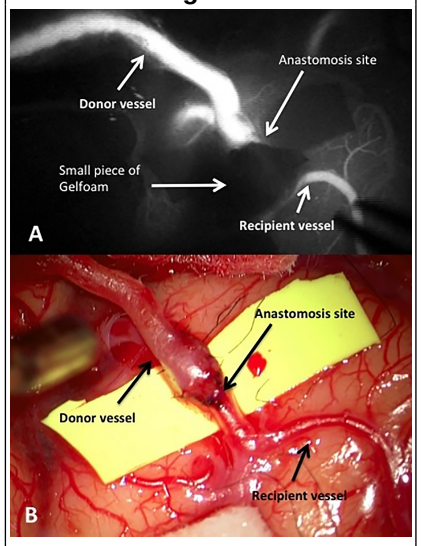
33 patients eligible for analysis were retrospectively analyzed. The patients had undergone extracranial-intracranial (EC-IC) or IC-IC bypass for ischemic stroke (13 patients), moyamoya disease (10 patients), and complex aneurysms (10 patients, 6 giant aneurysms, 2 carotid blister-like and 2 dissecting PICA). A total of 36 bypasses were performed including 26 STA-MCA, 6 EC-IC vein grafts, 1 EC-IC radial artery graft, 1 PICA-PICA, 1 MCA-PCA, and 1 OA-PICA grafts.

Conclusion:

ICG videoangiography is reliable for evaluating the flow through the EC-IC or IC-IC bypass. The type of flow observed through the graft has a direct relationship with post-operative imaging findings. Despite the possibility of competitive flow, Type III and some Type II flow through the graft indicate the need for graft evaluation and anastomosis exploration.

All patients were evaluated with intraoperative ICG and/or DSA, and all had postoperative CTA or angiograms within 24-72 hours of surgery. Robust anterograde flow (Type I) [Fig. 1, video on the left] was noted in 31 grafts (86%). Delayed but patent graft enhancement and anterograde flow (type II) [Fig. 3, video on the right) was observed in 4 cases (11%). One of those with EC-IC vein graft degraded gradually to very delayed flow with no continuity to the bypass site (Type III). Additionally, one STA-MCA bypass graft revealed no convincing flow (Type III). The 5 patients with type II or III grafts were evaluated by flow probe and re-exploration of the bypass site, and in all cases the reason the graft became occluded was believed to be recipient-vessel competitive flow. In no case was there evidence of stenosis or a technical issue at the site of the anastomosis. Three patients with Type II and the one with Type III flow did not have a patent bypass on post-operative imaging (11% non-patent).

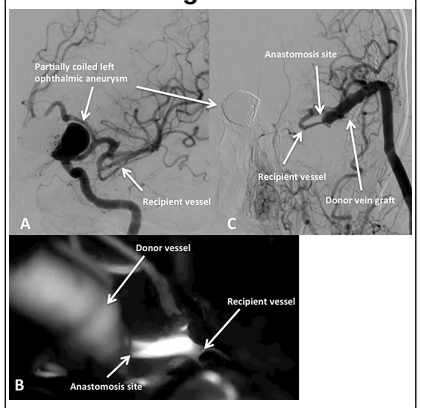
Figure 1



A) ICG-videoangiogrpahy showing Type I, robust enhancement of flow in an STA-MCA bypass. Very good flow is visualized between the donor and recipient vessels (see video below to visualize the immediate robust Type 1 flow through the bypass). B) Intraoperative microscope image showing the bypass site.

Movie

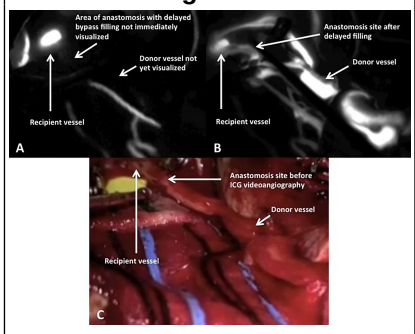
Figure 2



Preoperative DSA of a left giant partially coiled recurrent ophthalmic aneurysm (A) treated by high flow EC-IC vein bypass and trapping of the diseased segment. Intraoperative ICG videoangiography showing Type 1 flow (B) [see video below]. Postoperative DSA confirming the patency of the bypass and validating ICG findings (C)

Movie

Figure 3



ICG-videoangiography showing Type II OA-PICA bypass graft (A) only showing recipient vessel enhancing initially, (B) later enhancement of the bypass is visualized within 5 seconds of contrast injection (see video below to visualize the delayed flow). Small obscurities on the length of the graft are due to thick adventitia. C) Intraoperative microscope image showing good gross anastomosis

Movie