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Extracranial-Intracranial (EC-IC) Bypass Surgery: a Low-Complication, Successful, Treatment Option for Congenital Fusiform ICA Aneurysms

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Updated title:

Proximal ICA occlusion with EC-IC Bypass Surgery is Safe and Effective for Treatment of Fusiform ICA

Introduction

Our goal is to evaluate the adjunctive role of extracranial-to-intracranial (EC-IC) bypass to augment the safety of internal carotid artery (ICA) occlusion in the treatment of patients with congenital fusiform cranial ICA aneurysms. These lesions are rare, morbid, and can be challenging to treat 1. They are not amenable to endovascular coiling or microsurgical clipping, leaving variations of ICA occlusion as the primary treatment option. Though effective, ICA occlusion has shown a significant stroke risk. Treatment efficacy with flow diversion is unknown, though this strategy has proven problematic with large, fusiform aneurysms due to rate of incomplete treatment and association with branch vessel occlusion. No clear evidence exists to guide the use of EC-IC bypass in the treatment of these lesions. Many employ balloon test occlusion (BTO) to help guide this selection, but this procedure has an unacceptably high false negative rate.

Methods

A retrospective analysis of all patients with symptomatic fusiform cranial segment ICA aneurysms who underwent surgical treatment from August 2000 to November 2016. Fifteen patients (17 aneurysms) underwent a treatment strategy incorporating EC-IC bypass and ICA occlusion.

Results (see Table)

Mean age at presentation was 62 years and the median aneurysm size 30mm; most were large or giant when discovered. The median interval between symptom onset and treatment was 2.25 months. In our cohort, time to treatment did not correlate with symptom improvement or resolution, though other authors have posed that treatment should occur within 3 months of symptom onset for highest likelihood of full symptom resolution 1. All of our patients underwent a form of EC-IC bypass, regardless of pre-operative BTO result. BTO helped guide the choice of conduit for bypass, and whether to stage the procedure or do the ICA occlusion and revascularization simultaneously. One patient required re-treatment for partial aneurysm occlusion; aneurysm treatment was complete and durable in 12 of 13 (92.3%) of patients completing surgical treatment. One patient did not undergo planned staged ICA occlusion after failing BTO—this patient was treated using flow diversion. Three of 15 patients (20.0%) suffered a major treatment-related complication. Two suffered peri-operative strokes, and one suffered a peri-operative intraparenchymal hemorrhage. Three patients suffered events unrelated to their aneurysm treatment which affected their functional outcomes. Eleven of 15 (73.3%) patients witnessed significant improvement or complete resolution of pre-operative symptoms. Ten of 15 (66.7%) patients had a Glasgow Outcome Scale of 5 at last follow up.

Conclusions

* Our series illustrates that EC-IC bypass can be used to augment the safety of proximal ICA occlusion in treating patients with fusiform ICA aneurysms. Aneurysm treatment efficacy was 92.3%, and there were no long-term bypass graft-related complications.
* Our series is not large enough to inform bypass graft selection. Interestingly, one patient who suffered a peri-operative stroke received a "high-flow" radial artery interposition graft, whereas no patients who underwent "low-flow" bypasses and proximal ICA ligation suffered peri-operative strokes.
* BTO tolerance was used to guide ICA occlusion in several cases, though we have ceased to employ this strategy. Two patients who suffered strokes had passed BTO. These patients were also occluded more distally along the ICA, one by coil embolization and one by Hunterian ligation.
* Ultimately, individual patient characteristics and risk factors must be carefully weighed when deciding on a treatment strategy. In general, patients medically able to tolerate EC-IC bypass surgery and proximal ICA occlusion should be evaluated for this treatment strategy preferentially.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the role of balloon test occlusion in EC-IC bypass surgical decision-making for these patients, 2) Discuss, in small groups, the risks and benefits of surgical revascularization in these patients, 3) Identify the indications for EC-IC bypass and situations suitable for its implementation in these patients.

Fusiform ICA aneurysm characteristics, treatment, complications and follow-up

Case	Age	Size (mm)	ICA Location	Presentation	BTO	Treatment	Bypass	Time to treatment (mos)	Total hospital days	Follow up (days)	Aneurysm treatment result	Complications	GOS	Symptoms post-treatment
1	84	15	Left cavernous sinus	CN VI palsy, decreased hearing	Failed	Observation (3 years), then ICA occlusion aborted due to failed BTO after bypass, treated with flow diversion	STA-MCA x1	37	9	25	Partial occlusion	None	5	Improved
2	80	30	Left supraclinoid	CN III palsy	Passed	ICA occlusion and stroke with coiling attempt, salvage EC-IC bypass performed	STA-MCA x1	1	8	3	Inadvertently occluded	Unrelated to surgery--stroke occurred with prior coiling attempt	4	Worse
3	76	35	Right cavernous	HA, diplopia, CN VI palsy	Not tested	Plan for staged BTO and coili	STA-MCA x1	2	25	N/A	Not treated	Peri-operative intraparenchymal hemorrhage	1	Brain death
4	70	48	Left supraclinoid	Cognitive impairement,	Not tested	Observation (3 years) then EC-IC bypass	STA-MCA x1	36	16		Complete occlusion	None	5	Improved
5	68	61	Right supraclinoid	HA, blurry vision	Not tested	Proximal ligation	ECA-M2 (radial)	12	30	90	Complete occlusion	Peri-operative stroke	3	Resolved
6	67	30	Right opthalmic	HA, N/V, blurry vision, weakness	Failed	Staged BTO and coil occlusion	STA-MCA x1	4	13	180	Partial occlusion	Unrelated to surgery--remote stroke due to ECA atherosclerosis	5	Improved
7	67	20	Left cavernous	HA, blurry vision	Passed	Proximal ligation	STA-MCA x1	23	7	40	Complete occlusion	None	5	Resolved
8	57	8, 15	Left supraclinoid, Left opthalmic	Hemifacial spasm	Not tested	Proximal ligation	STA-MCA x1	2	8		Complete occlusion x2	None	5	Resolved
9	48	30	Left supraclinoid	HA, blurry vision, CN VII palsy	Passed	Hunterian Ligation	STA-M2 x1	2	22	90	Complete occlusion, re-treated with coiling	Peri-operative stroke	3	Worse
10	41	20	Right supraclinoid	HA	Not tested	Proximal ligation	STA-M2 x1	0.5	10	20	Complete occlusion	None	5	Resolved
11	40	23, 17	Left petrocavernous, Right cavernous	HA, blurry vision, CN III palsy	Passed	Staged BTO and coil occlusion	STA-MCA x1	14	22	17	Complete occlusion	None	5	Resolved
12	40	30	Left petrocavernous	HA, blurry vision	Failed	Proximal ligation	ECA-M2 (saphenous)	0.5	15	7	Complete occlusion	None	5	Worse
13	28	35	Right petrocavernous	HA, N/V, diplopia, CN VI palsy	Passed	Proximal ligation	STA-MCA x1	2.5	13		Complete occlusion	None	5	Resolved
14	12	33	Left petrous	V2 numbness, slurred speech	Passed	Proximal ligation	STA-MCA x2	0.5	17	N/A	Complete occlusion	Unrelated to surgery--patient died of rupture of another aneurysm	1	Resolved
15	15	34	Right petrocavernous	N/V, blurry vision, decreased hearing	Passed	Proximal ligation	STA-MCA x2	6	6	12	Partial occlusion	None	5	Resolved

ICA, internal carotid artery; CN, cranial nerve; BTO, balloon test occlusion; HA, headache; N/V, nausea/vomiting; ICH, intracranial hemorrhage; STA, superficial temporal artery; MCA, middle cerebral a

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