Universal Extracranial-Intracranial Graft Bypass for Large or Giant Internal Carotid Aneurysms: Techniques and Results in 38 Consecutive Patients

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Key words
- Cerebral revascularization
- Extracranial-intracranial bypass
- Giant aneurysm
- Internal carotid aneurysm

Abbreviations and Acronyms
BTO: Balloon temporary occlusion
CTA: Computed tomographic angiography
ECA: External carotid artery
EC-IC: Extracranial-intracranial
ICA: Internal carotid artery
ISUIA: International Study of Unruptured Intracranial Aneurysms
MCA: Middle cerebral artery
MRA: Magnetic resonance arteriography
OphA: Ophthalmic artery
RA: Radial artery
SAH: Subarachnoid hemorrhage
STA: Superficial temporal artery
SV: Saphenous vein

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OBJECTIVE: **To present indications, surgical techniques, and outcomes of extracranial-intracranial (EC-IC) graft bypass.**

METHODS: **Between January 1996 and June 2011, 38 patients with large or giant internal carotid artery (ICA) aneurysms were treated using graft bypass, employing the radial artery (RA) or the saphenous vein (SV) as a graft. Preoperative balloon test occlusions were not performed in any of the cases. In 17 patients, the external carotid artery (ECA)-RA-M2 segment of the middle cerebral artery bypass was used for treatment, and ECA-SV-M2 bypass was used in 21 patients.**

RESULTS: **All aneurysms were completely trapped, and there were no subarachnoid hemorrhages or recanalizations of aneurysms during the follow-up period (8–170 months). Of the 38 bypasses, 36 (94.7%) remained patent, and there were no permanent neurologic deficits. Hyperperfusion syndrome was not experienced in this series. There were 2 temporary neurologic deficits. In 1 case using the RA, graft vasospasm occurred, and kinking occurred in 1 case using the SV. Another patient with a SV graft had to undergo an emergent revision of the graft 8 hours after the initial operation. One patient with a SV graft underwent a second operation to control an epidural abscess.**

CONCLUSIONS: **Universal EC-IC graft bypass is a safe and effective method for treating large or giant ICA aneurysms.**

INTRODUCTION

Large or giant aneurysms of the intracranial internal carotid artery (ICA) can lead to severe morbidity or death secondary to progressive disability from mass effect, ischemia, or subarachnoid hemorrhage (SAH). The risk of rupture of intracranial ICA aneurysms >25 mm in diameter is 40% within 5 years according to ISUIA (International Study of Unruptured Intracranial Aneurysms) (46). Although most extradural cavernous carotid aneurysms are considered benign, 6.4% of aneurysms >25 mm in diameter bleed and cause difficult-to-treat carotid cavernous fistula within 5 years according to ISUIA (46). Progressive mass effect of the aneurysm dome on the cavernous sinus can induce symptoms associated with cranial nerves. In cases of giant aneurysms or symptomatic cases, not only intracranial ICA but also extracranial cavernous carotid aneurysms can be considered for treatment. Cerebral revascularization is often used to treat these aneurysms to compensate for the temporal or permanent occlusion of the affected artery. Graft bypass using the radial artery (RA) or saphenous vein (SV) is promising to replace the ICA (24) but is considered technically challenging (26).

Video

Video available at WORLDNEUROSURGERY.org

Our policy for these complex aneurysms is first to make a graft bypass with RA or SV graft in all cases that potentially need ICA occlusion. We have termed this procedure "universal extracranial-intracranial (EC-IC) graft bypass" (23). In this report, we present surgical techniques and the outcomes of our 38 consecutive cases.

METHODS

Clinical Material

Between January 1996 and June 2011, 38 consecutive patients with large or giant ICA aneurysms were treated using graft bypass. Of these patients, 17 underwent external carotid artery (ECA)-RA-M2 bypass, and 21 underwent ECA-SV-M2 bypass. The clinical features are listed in **Table 1**.

Surgical Technique

Video 1 demonstrates the surgical technique of graft bypass. The ipsilateral cervical common carotid artery, ICA, and ECA were

Table 1. Patient Summary

Patient Number	Age (years)/ Sex	Aneurysm			SAH	Symptom	Graft	Complication	Graft Patency	Treatment	GOS
		Location	Side	Size*							
1	58/F	Cavernous	R	Giant	–	–	RA	–	Good	Ligated	GR
2	69/F	Cavernous	L	Giant	–	–	RA	–	Good	Ligated	GR
3	67/F	SHA	R	Giant	–	–	RA	–	Good	Trapped	GR
4	48/M	C2	R	Large	+	+	RA	–	Good	Trapped	GR
5	33/F	PCoA	L	Large	–	–	RA	–	Good	Trapped	GR
6	75/F	Cavernous	R	Giant	–	+	RA	–	Good	Ligated	GR
7	47/F	C2	R	Large	–	–	RA	–	Good	Trapped	GR
8	46/F	C2	R	Large	–	–	RA	–	Good	Trapped	GR
9	64/F	OphA	L	Large	–	–	RA	–	Good	Trapped	GR
10	72/F	Cavernous	R	Giant	–	–	RA	–	Good	Ligated	GR
11	62/F	Cavernous	R	Giant	–	–	RA	–	Good	Ligated	GR
12	57/F	OphA	L	Giant	–	–	RA	–	Good	Trapped	GR
13	30/F	C2	L	Large	–	–	RA	Transient motor aphasia owing to RA vasospasm	Good	Trapped	GR
14	48/F	Cavernous	L	Giant	–	+	RA	–	Good	Ligated	GR
15	61/M	PCoA	R	Giant	–	+	RA	–	Good	Trapped	GR
16	54/M	C2	L	Large	–	–	RA	Epidural abscess	Good	Trapped	GR
17	74/F	SHA	R	Large	–	–	RA	–	Good	Trapped	GR
18	64/F	SHA	R	Large	–	–	SV	–	Good	Trapped	GR
19	45/M	C2	L	Giant	–	+	SV	–	Good	Trapped	GR
20	57/F	OphA	L	Giant	+	+	SV	–	Good	Trapped	GR
21	30/M	C2	R	Large	+	+	SV	–	Good	Trapped	GR
22	65/F	Cavernous	L	Giant	–	+	SV	–	Good	Ligated	GR
23	57/F	OphA	R	Large	–	–	SV	–	Occlusion (6 months later)	Trapped	GR
24	44/M	Cavernous	R	Giant	+	+	SV	–	Good	Ligated	GR
25	10/M	C2	L	Giant	–	–	SV	Transient oculomotor palsy	Occlusion (5 months later)	Trapped	GR
26	80/F	Cavernous	R	Giant	–	+	SV	–	Good	Ligated	GR
27	73/F	Cavernous	L	Giant	–	+	SV	–	Good	Ligated	GR
28	57/F	Cavernous	R	Giant	–	–	SV	–	Good	Ligated	GR
29	64/F	Cavernous	R	Giant	–	–	SV	–	Good	Ligated	GR
30	58/F	Cavernous	R	Giant	–	+	SV	–	Good	Ligated	GR
31	58/F	OphA	L	Giant	–	–	SV	–	Good	Trapped	GR
32	57/F	Cavernous	R	Giant	–	–	SV	–	Good	Ligated	GR
33	60/F	Cavernous	L	Giant	–	–	SV	–	Good	Ligated	GR
34	77/F	OphA	L	Giant	–	+	SV	Graft kinking	Good	Trapped	GR

SAH, subarachnoid hemorrhage; GOS, Glasgow Outcome Scale; F, female; M, male; SHA, superior hypophyseal artery; PCoA, posterior communicating artery; OphA, ophthalmic artery; R, right; L, left; RA, radial artery; SV, saphenous vein; GR, good recovery.

*Large, 10–24 mm; giant, ≥25 mm.

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