

Clinical Article

The Efficacy of Simultaneous Bilateral Internal Carotid Angiography during Coil Embolization for Anterior Communicating Artery Aneurysms

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Objective : Successful coil embolization of anterior communicating (A-com) artery aneurysms requires good visualization and understanding of the entire H complex. Bilateral carotid angiography may optimize anatomical understanding and visualization of the H complex. We therefore assessed the efficacy of simultaneous bilateral internal carotid angiography during coil embolization for A-com artery aneurysms.

Methods : Of the 153 patients with intracranial saccular aneurysms who underwent embolization between July 2008 and December 2009, 12 had A-com artery aneurysms and were embolized under bilateral carotid angiography. Patients were evaluated angiographically, immediately and 6 months (n=11) after embolization, using a 3-point scale (complete, residual neck, residual aneurysm). The safety, performance and efficacy of this approach were retrospectively evaluated.

Results : In all patients, bilateral internal carotid artery angiography provided more detailed anatomical information and understanding around the A-com artery, and, in complex situations, it allowed for more effective coil embolization through bilateral routes to the A-com artery. Angiography immediately after embolization showed occlusion of 11 of the 12 (92%) aneurysms, with none of these 11 showing evidence of recanalization at 6 months.

Conclusion : These findings indicate that simultaneous bilateral carotid angiography during coil embolization of selected complex A-com artery aneurysms provided improved anatomical understanding, and resulted in more effective and safer procedures than typical unilateral angiography.

Key Words : Coil embolization · A-com artery · Aneurysm · Bilateral carotid angiography.

INTRODUCTION

The anterior communicating (A-com) artery is the most common single location for intracranial aneurysms^{4,6}. However, the anatomy of this artery is very complex, with many individual hemodynamic variations.

Good visualization and understanding of the entire H complex prior to coil embolization is the key to successful neurointervention for complex aneurysms of the A-com artery. Visualization may be limited, however, by many factors including bilateral arterial supply, flow competition, and many individual anatomical variations.

To overcome these limitations, we have utilized, for selected A-com artery aneurysms, a procedure involving bilateral femoral puncture followed by placement of guiding catheters into both internal carotid arteries (ICAs). We then performed simultane-

ous bilateral internal carotid angiography during coil embolization. We describe here our experience with such 12 patients.

MATERIALS AND METHODS

Patients

From July 2008 to December 2009, 153 patients with intracranial saccular aneurysms at our institution were managed by endovascular coil embolization. Of these, 12 had complex A-com artery aneurysms on computed tomography angiography and cerebral angiography. Nine cases showed limited anatomical information of H-complex, especially origin of contralateral A2 related to aneurismal sac, by unilateral ICA angiography. In 3 cases, we planned and did coil embolization through bilateral routes for A-com crossing neck remodeling technique with balloon. These patients were embolized under bilateral carotid angiography (Table 1). Ten patients presented with acute subarachnoid hemorrhaging due to ruptured aneurysms, and 2 had incidentally detected un-ruptured aneurysms.

Endovascular treatment

All 12 patients underwent routine cerebral angiography using

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a biplane angiomaachine (Siemens Biplane, Neurostar Top, Germany). We chose the approach side for endovascular coil embolization based on the anatomical details of each patient including aneurismal shape, dome direction and A1 segment dominance.

Usually, a 6-French guiding catheter was placed in the working-side cervical ICA as possible as distal using a coaxial method. A 5-French guiding catheter was then positioned in the contralateral proximal ICA through the other femoral route (Fig. 1). During the entire procedure, the vessels on both sides were continuously flushed with a heparin-saline solution to prevent thromboembolic complications.

All patients subsequently underwent simultaneous bilateral ICA angiography to obtain the detailed anatomy of the H-complex (Fig. 2). Coil embolization was then performed using standard procedures, although it was performed through bilateral routes in 3 cases.

Angiographic and clinical evaluation

Of the 12 patients, one died soon after embolization due to

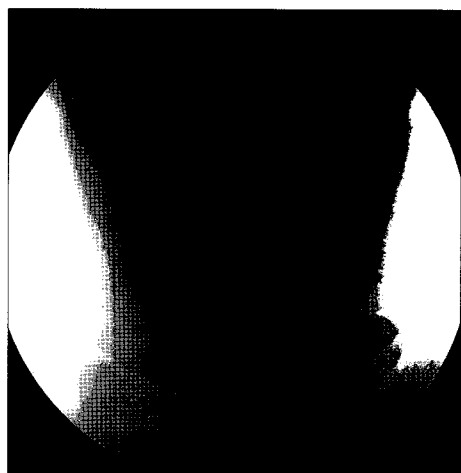


Fig. 1. Fluoroscopic anteroposterior view showing a coaxially placed 6-French guiding catheter in the left ICA, and a 5-French guiding catheter in the contralateral proximal ICA. ICA : internal carotid artery.

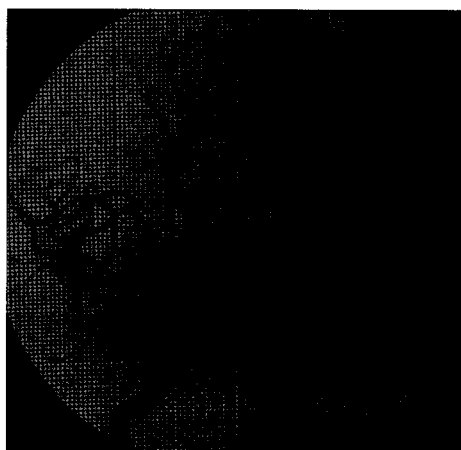


Fig. 2. Frontal projection of the simultaneous bilateral ICA angiogram of patient 4 in Table 1 showing more detailed and complete anatomical H-complex information. ICA : internal carotid artery.

Table 1. Summary of patients

Case	Age/Sex	Direction of Aneurysm	Rupture	HH	Longest diameter of An. (mm)	Time for procedure (min)	Packing density (%)	Angiographic results	mRS at Discharge	6 month, angiographic results	Consumed benefit
1	55/F	Superior	R	3	3 (3x2.5x2.5)	90	19	3	1	2	Detailed anatomic information
2	45/M	Superior	R	3	2.7 (2.7x2.5x2.2)	80	58	1	3	1	Safe remodeling
3	63/M	Anterosuperior	U	0	4.8 (4.8x4.5x4.2)	120	35	2	0	2	Detailed anatomic information
4	48/M	Anterosuperior	R	2	7 (7x5x5)	140	32	2	1	2	Detailed anatomic information
5	69/F	Inferior	U	0	5.5 (5.5x4.5x4)	160	51	1	0	1	Effectively preserving the distal ACA
6	28/F	Anteroinferior	R	3	3.5 (3.5x2.5x2)	110	105	1	1	1	Effectively preserving the distal ACA
7	48/F	Anterosuperior	R	3	3.5 (3.5x3.5x2.7)	120	54	1	0	1	Effectively preserving the distal ACA
8	39/M	Anteroinferior	R	3	7.5 (7.5x6.4x6.2)	170	48	1	2	1	Effectively preserving the distal ACA
9	50/M	Anteroinferior	R	3	4.2 (4.2x3.9x3.8)	130	69	1	2	1	Safe remodeling
10	63/M	Anteroinferior	R	5	5.4 (5.4x3.2x2.7)	160	63	1	6	NA	Detailed anatomic information
11	46/F	Anterosuperior	R	3	3.4 (3.4x2.9x2.5)	110	45	1	3	1	Safe remodeling
12	42/F	Inferior	R	3	7.1 (7.1x4.7x4.1)	100	43	2	1	2	Detailed anatomic information

Immediate and 6 month follow-up angiographic results were classified using the Raymond classification system : class 1, complete occlusion ; class 2, residual neck ; class 3, residual sac. R : ruptured, U : unruptured, HH : Hunt-Hess SAH classification, mRS : Modified Rankin Scale, NA : not available. ACA : anterior cerebral artery

poor general condition. The remaining 11 patients underwent follow-up digital subtraction angiography 6 months after treatment. The degrees of angiographic occlusion immediately after treatment and 6 months later were classified using the Raymond classification system (complete, residual neck, residual aneurysm)⁹. Patient outcomes at discharge were graded using the modified Rankin Scale (mRS).

RESULTS

The total aneurysm volume ranged from 0.008 cc to 0.156 cc (mean, 0.042 cc), and the calculated packing density using AngioCalc (<http://www.angiocalc.com>) ranged from 19% to 105% (mean, 52%). The average time for the entire procedure was 124.2 minutes (range, 80 to 170 minutes).

Angiograms performed immediately after treatment showed occlusion in 11 of the 12 (91.7%) aneurysms (class 1 or 2 on the Raymond classification system). Angiograms performed 6 months later showed no evidence of recanalization in the 11 remaining patients.

At discharge, 9 patients were independent, with mRS scores of 0-2, whereas 2 were dependent, with mRS scores of 3-6. One patient died because of poor clinical status at admission.

Simultaneous bilateral ICA angiography was successful in obtaining more detailed and complete anatomical information of the H complex in all 12 patients. This approach resulted in safe remodeling through the A-com artery in 3 patients due to full visualization of the H complex (Fig. 3), and in 4 patients we were able to place another microcatheter on contralateral A2 for effective preservation of distal anterior cerebral arteries (Fig. 4, 5).

There were no complications related to bilateral angiography.

DISCUSSION

A-com artery aneurysms are complex due to frequent anatomical variations⁹. Full visualization of the major arterial trunks and perforating arteries in this area is critical for successful outcomes of both clipping and coiling procedures.

The International Subarachnoid Aneurysm Trial showed that endovascular treatment of intracranial aneurysms is an effective and safe alternative management strategy⁷. However, although procedural techniques and technology have improved, the rate of aneurysmal total occlusion remains suboptimal^{2,5}. Coil embolization procedures are frequently more difficult for A-com artery than for other intracranial aneurysms due to anatomical complexity at the midline and occasional flow competition around the A-com artery due to a dual arterial supply. One study found that the rate of complete endovascular occlusion of A-com artery aneurysms was 45.5%¹.

Sometimes procedural limitations may occur during typical coil embolization of A-com artery aneurysms under the guidance of unilateral ICA angiography (Fig. 6). Moreover, flow competition around the A-com artery may prevent full visualization

of the H-complex. Greater anatomical detail, including details of the entire H-complex, can sometimes be obtained by cross neck compression during unilateral ICA angiography, but misregistration may occur due to motion artifacts.

Simultaneous dual vessel cerebral angiography has been used for gamma knife planning in 7 patients with arteriovenous malformations³. And, simultaneous bilateral internal carotid artery 3D rotational angiography was previously shown effective in a patient with a ruptured A-com artery aneurysm¹⁰. This patient was similar to the 12 patients described here, who underwent bilateral ICA angiography for coil embolization of A-com artery aneurysms. This procedure, which provided greater anatomical information and understanding, resulted in more effective

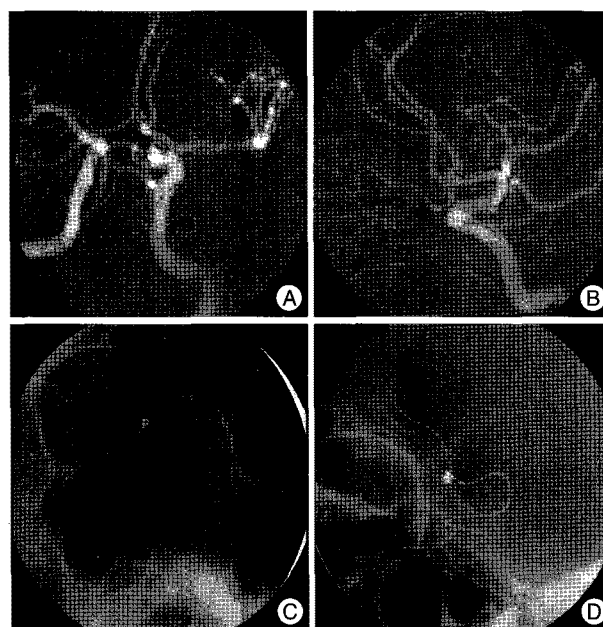


Fig. 3. Frontal (A) and lateral (B) projections of roadmap views of bilateral ICA angiograms of Patient 2 in Table 1 showing a balloon in the A-com artery and a microcatheter in the aneurysm. Post-coiling fluoroscopic frontal (C) and lateral (D) views showing effective coil mesh in the aneurismal sac. ICA : internal carotid artery.

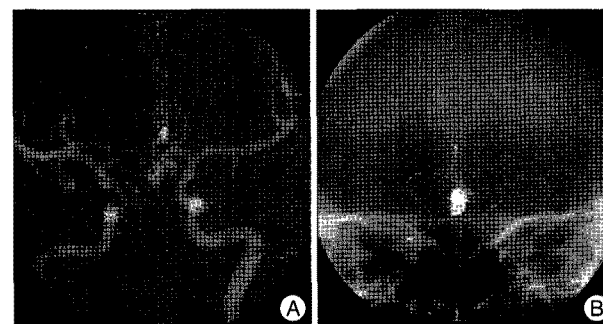


Fig. 4. A : Frontal projection of a roadmap view of the bilateral ICA angiogram of patient 12 in Table 2 showing the complex anatomy of the A-com aneurysm. A balloon was inserted through the right ICA for A-com preservation, and a double microcatheter was inserted through the left ICA for coiling on the aneurismal sac. B : Post-coiling fluoroscopic frontal view of this patient showing a densely packed coil mesh in the aneurismal sac.

tive and safer aneurysm embolization in all patients. Moreover, bilateral ICA angiography enabled the performance of more complex procedures, including A-com artery crossing, neck remodeling or the use of more devices through bilateral routes to the A-com artery.

This study had several limitations. First, the enrolled number of cases was small. However, indications for this approach are very limited because most of A-com artery aneurysms could be embolized through unilateral ICA route thus most patients with A-com aneurysms are not indicated for such bilateral approach. Second, this approach may have shortcomings, including the additional risks associated with access to a second femoral artery and the use of more contrast material. However, fewer than 4% of patients experienced adverse events following catheterization of the femoral artery, with the most common adverse event being local bleeding with hematoma¹¹). None of our patients had morbidities related to access to the femoral arteries. Moreover, since bilateral angiography is performed only occasionally, few patients require higher amounts of contrast material compared with the quantities used during most coil embolization procedures.

CONCLUSION

Bilateral ICA angiography resulted in more effective and safer coil embolization for selected complex A-com aneurysms due to greater anatomical understanding. The procedure was relatively simple and not time-consuming compared with routine coil embolization procedures for A-com artery aneurysms through unilateral ICA angiography. This procedure may be more effective method in coil embolization of selected A-com artery aneurysms, especially in cases of limited anatomical details for H-complex through unilateral ICA angiography or for more complex procedures.

References

1. Guglielmi G, Viñuela F, Duckwiler G, Jahan R, Cotroneo E, Gigli R : Endovascular treatment of 306 anterior communicating artery aneurysms : overall, perioperative results. *J Neurosurg* 110 : 874-879, 2009
2. Hayakawa M, Murayama Y, Duckwiler GR, Gobin YP, Guglielmi G, Viñuela F : Natural history of the neck remnant of a cerebral aneurysm

treated with the Guglielmi detachable coil system. *J Neurosurg* 93 : 561-568, 2000

3. Joseffer SS, Huang PP, Nelson PK : Simultaneous dual vessel cerebral angiography in gamma knife planning. *AJNR Am J Neuroradiol* 24 : 271-274, 2003
4. Kassell NF, Torner JC, Haley EC Jr, Jane JA, Adams HP, Kongable GL : The International Cooperative Study on the Timing of Aneurysm Surgery. Part 1 : Overall management results. *J Neurosurg* 73 : 18-36, 1990
5. Kole MK, Pelz DM, Kalapos P, Lee DH, Gulka IB, Lownie SP : Endovascular coil embolization of intracranial aneurysms : important factors related to rates and outcomes of incomplete occlusion. *J Neurosurg* 102 : 607-615, 2005
6. Locksley HB : Natural history of subarachnoid hemorrhage, intracranial aneurysms and arteriovenous malformations. Based on 6368 cases in the cooperative study. *J Neurosurg* 25 : 219-239, 1966

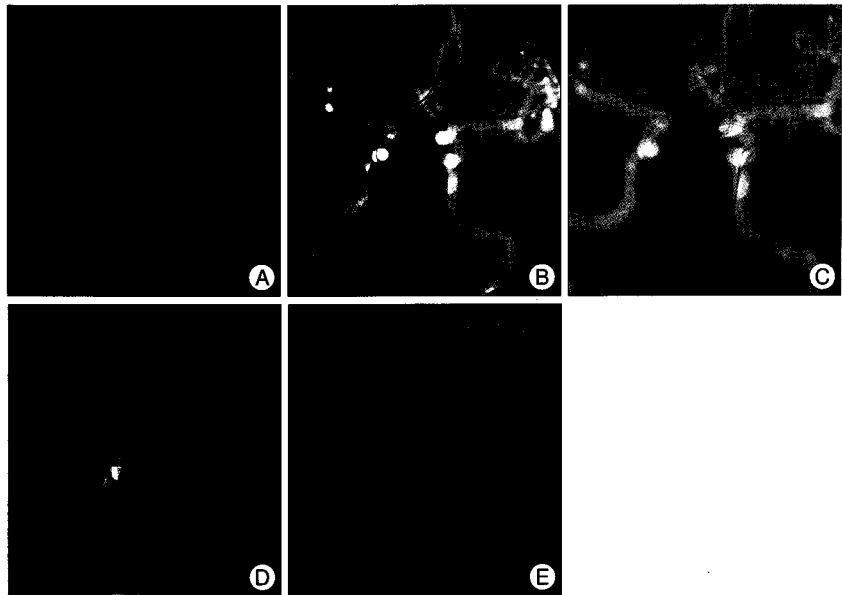


Fig. 5. A : Frontal projection of a simultaneous bilateral ICA angiogram of Patient 7 in Table 2 showing the H-complex and the A-com artery aneurysm. B : One microcatheter with a microwire was inserted through the right ICA for preservation of the right distal ACA. C : Frontal projection of a roadmap view of the bilateral ICA angiogram showing the balloon on the aneurysmal neck and the microcatheter on the aneurysm sac. D : Fluoroscopic frontal view showing a coil mesh under balloon assistance. E : Final post-coiling, frontal projection of the simultaneous bilateral ICA angiogram showing total occlusion of the aneurysmal sac. ICA : internal carotid artery. ACA : anterior cerebral artery.

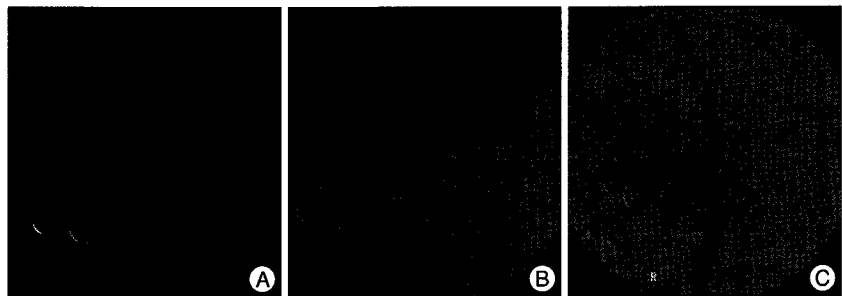


Fig. 6. Typical coil embolization of an A-com artery aneurysm through a unilateral ICA. A : Frontal working projection image from a digital subtraction angiogram of the left ICA showing the coil on the aneurysmal sac and a well-preserved bilateral distal ACA. B : Following additional coil packing on the aneurysmal sac, the contralateral distal ACA flow was diminished. C : Frontal working projection image of a digital subtraction angiogram of the contralateral (right) ICA after removal of the microcatheter and guiding catheter from the left ICA showing preservation of the contralateral distal ACA flow. ICA : internal carotid artery. ACA : anterior cerebral artery.

7. Molyneux A, Kerr R, Stratton I, Sandercock P, Clarke M, Shrimpton J, et al. : International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms : a randomised trial. *Lancet* **360** : 1267-1274, 2002
8. Rhoton AL Jr : Aneurysms. *Neurosurgery* **51** : S121-S158, 2002
9. Roy D, Milot G, Raymond J : Endovascular treatment of unruptured aneurysms. *Stroke* **32** : 1998-2004, 2001
10. Song JK, Nimi Y, Brisman JL, Berenstein A : Simultaneous bilateral internal carotid artery 3D rotational angiography. *AJNR Am J Neuroradiol* **25** : 1787-1789, 2004
11. Tavaris DR, Dey S, Albrecht-Gallauresi B, Brindis RG, Shaw R, Weintraub W, et al. : Risk of local adverse events following cardiac catheterization by hemostasis device use - Phase II. *J Invasive Cardiol* **17** : 644-650, 2005