

# Angle change of the parent arteries after stent-assisted coil embolization of wide-necked intracranial bifurcation aneurysms



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**AIM:** To investigate the angle changes of the parent arteries after stent-assisted coil embolization of wide-necked intracranial bifurcation aneurysms.

**MATERIALS AND METHODS:** The adjacent parent arterial angles before and after stent-assisted coil embolization were measured in 38 patients with aneurysms of the anterior communicating artery (ACoAA) and 41 patients with bifurcation aneurysms of the middle cerebral artery (MCABA). Variables were analysed in relation to the angle changes.

**RESULTS:** Vascular angles of the parent arteries significantly increased by 27.8° (±18.5°) immediately after stent-assisted coil embolization in 79 cases ( $p < 0.001$ ), with 25.7° (±14.8°) in ACoAA and 29.7° (±21.4°) in MCABA, respectively. In 51 (64.6%) cases with follow-up angiography (mean interval 13.5 ± 4.1 months), vascular angles increased by 27.2° (±17.1°) immediately after treatment and further increased by 20.7° (±14.3°) at the last follow-up (all  $p < 0.001$ ). More acute pre-stent angles of the parent arteries correlated with greater post-stent angle changes ( $p = 0.006$ ). Younger age tended to be inversely related to post-stent angle changes ( $p = 0.091$ ).

**CONCLUSION:** Stent placement during coil embolization induced significant changes in the aneurysm–parent artery relationship. Further study is needed to elicit the association between angle change of the parent arteries and aneurysmal stability after coil embolization.

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## Introduction

Coil embolization is widely accepted as a safe and effective treatment modality for intracranial aneurysms.<sup>1</sup> As new devices and techniques are developed, aneurysms of various forms, such as wide-necked, fusiform, and

dissecting as well as saccular ones, have been effectively treated by endovascular methods. Among them, stent-assisted coil embolization is one of the key technical evolutions. Stent support across the aneurysmal neck helps to prevent coil protrusion into the parent artery and to occlude the aneurysms compactly with more coils. In addition, stenting is considered to induce progressive occlusion of less completely occluded aneurysms and decrease in recanalization by reducing hemodynamic stress,<sup>2–14</sup> and promote remodelling of the pathological aneurysm neck and parent artery by providing a biological matrix for endothelial growth.<sup>15</sup> Recently, clinical studies on stent-

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assisted coil embolization have reported overall outcomes with little concern regarding geometric changes between the parent arteries and aneurysms.

During stent-assisted coil embolization, angle changes of the parent arteries are frequently observed, especially in cases of the bifurcation aneurysms (Fig 1). According to computational fluid dynamics (CFD) studies,<sup>2,3,7,12</sup> the parent arterial angle is considered as one of the important haemodynamic factors in terms of aneurysmal development, growth, and rupture. The present study was undertaken to investigate the phenomenon of angle change in the parent arteries and assessed the results of stent-assisted coil embolization of intracranial bifurcation aneurysms located at the anterior communicating artery (ACoAA) and the bifurcation of middle cerebral artery (MCABA).

## Materials and methods

### Patients

Under approval of the institutional review board, 79 patients who underwent stent-assisted coil embolization of ACoAA and MCABA during the period from November 2008 to April 2011 were retrospectively reviewed. The male-to-female ratio was 1:1.8 (28:51), and mean age was  $59.9 \pm 9.7$  years (range 37–78 years). The numbers of ACoAA and MCABA were 38 and 41, respectively. There were two ruptured and 16 recanalized aneurysms. Aneurysmal volume was  $115.6 \pm 312$  mm<sup>3</sup> (range 6–2356 mm<sup>3</sup>), and maximal diameters were <5 mm in 31, 5–10 mm in 29, and >10 mm in three aneurysms, excluding 16 recanalized aneurysms. The baseline characteristics of the patients and aneurysms are summarized in Table 1.

### Interventional procedures

For antiplatelet premedication, a 300 mg loading dose of clopidogrel was given the day before the procedure or 600 mg on the procedural day. A 75 mg maintenance dose was given for previous long-term users of clopidogrel without loading. After the stent-assisted coil embolization, clopidogrel was prescribed for 1–3 months, and 100 mg

**Table 1**

Baseline characteristics of 79 patients treated with stent-assisted coil embolization.

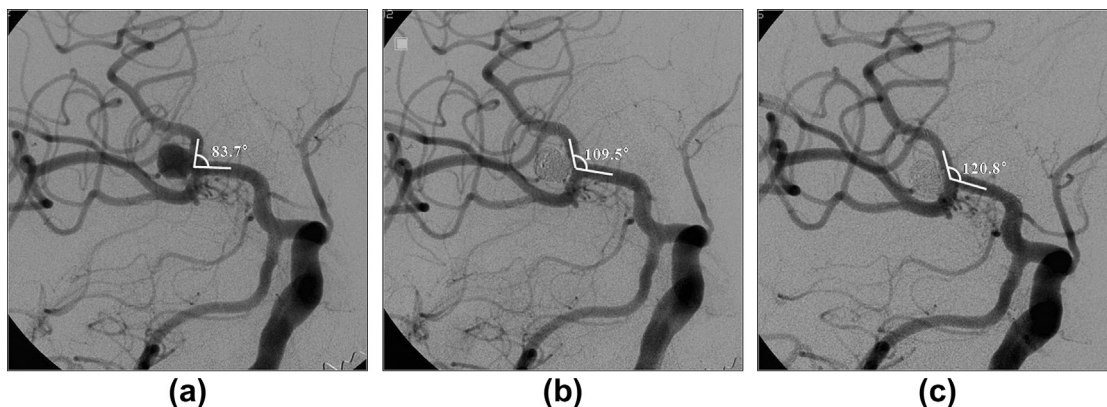
Male:female	1:1.8 (28:51)
Age, years (range)	$59.9 \pm 9.7$ (37–78)
Aneurysm characteristics	
Location	
Anterior communicating artery	38 (48.1%)
Bifurcation of middle cerebral artery	41 (51.9%)
Volume, <sup>a</sup> mm <sup>3</sup> (range)	$115.6 \pm 312$ (6–2356)
Maximal diameter, <sup>a</sup> mm	
<5	31 (49.2%)
5 ≤ and <10	29 (46.0%)
>10	3 (4.8%)
Risk factors	
Diabetes mellitus	5 (6.3%)
Hypertension	52 (65.8%)
Hyperlipidaemia	18 (22.8%)
Smoking	16 (20.3%)
Coronary heart disease	6 (7.6%)
Intracranial atherosclerotic stenosis	6 (7.6%)

<sup>a</sup> Volume and maximal diameter of aneurysms were calculated for 63 aneurysms excluding 16 recanalized ones.

aspirin was maintained thereafter. Medication was modified depending on the status of the underlying atherosclerotic disease and accompanying conditions.

Systemic heparin was administered after placement of the arterial introducer sheath. Heparin was usually administered as a 3000 IU intravenous bolus injection, followed by an additional 1000 IU injection per hour with monitoring of the activated coagulation time. Heparin was usually discontinued at the end of the procedure.

Coil embolization of the aneurysms was performed using a biplane angiographic system (Integris Allura; Philips Medical Systems, Best, the Netherlands). A plan of the procedure was made using three-dimensional (3D) reconstruction images by volume-rendering after rotational angiography with a software package (Integris 3D-RA release 3.2; Philips Medical Systems). At least two working projections that provided the best achievable view of the aneurysm neck were defined. Frontal, lateral, and working projections were acquired to rule out any parent artery or branch occlusion at the end of the procedure.



**Figure 1** An exemplary case. The parent arterial angle increases from 83.7° (a) to 109.5° (b) immediately after stent-assisted coil embolization. On 14-month follow-up cerebral angiography image (c), the angle of parent artery is more flattened (120.8°).

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