



Clinical Article

# Clinical and radiological outcomes of mechanical thrombectomy in simultaneous anterior cerebral artery and middle cerebral artery occlusion

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**Objective:** Simultaneous anterior cerebral artery (ACA) and middle cerebral artery (MCA) occlusion is rare. We investigated the clinical and radiological outcomes of patients with simultaneous ACA and MCA occlusion treated with mechanical thrombectomy.

**Methods:** We analyzed the clinical and radiological outcomes of 12 patients with simultaneous ACA and MCA occlusion treated with mechanical thrombectomy from January 2018 to December 2020. The clinical outcome was assessed using the modified Rankin Score (mRS) after 3 months of thrombectomy. The radiological outcome was assessed using the thrombolysis in cerebral infarction (TICI) score.

**Results:** The median National Institutes of Health Stroke Scale score at hospital arrival was 18 (interquartile range, 16–20). M1 was the most common occlusion lesion (n=8), and A3 was the most common lesion in the ACA (n=6). Six patients were first treated for MCA occlusion and later for ACA occlusion (MCA group). Other patients were first treated for ACA occlusion and later for MCA occlusion (ACA group). There was no difference in clinical outcomes between the MCA and ACA groups (p=0.180). Successful recanalization (TICI  $\geq 2b$ ) of MCA was achieved in 10 patients (83.3%). Successful recanalization of ACA was achieved in 10 patients (83.3%). Successful recanalization of both ACA and MCA occlusion was observed in eight patients (66.7%). Three patients (25%) had good clinical outcomes (mRS  $\leq 2$ ).

**Conclusions:** In our series, simultaneous ACA and MCA occlusion showed relatively poor successful recanalization rates and poor clinical outcomes despite treatment with mechanical thrombectomy.

**Keywords** Thrombectomy, Ischemic stroke, Middle cerebral artery, Anterior cerebral artery

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## INTRODUCTION

A few case of the simultaneous anterior cerebral artery (ACA) and middle cerebral artery (MCA) occlusion has been reported.<sup>4)11)</sup> Accordingly, the mechanical

thrombectomy strategy for this dual lesion has not reached consensus among neuro-interventionists. Although mechanical thrombectomy of iatrogenic ACA occlusion or pure ACA occlusion has been reported to have favorable clinical and radiological outcomes, the clinical and radiological outcomes of mechanical thrombectomy in this dual lesion are not well known.<sup>10)12)</sup>

Despite successful recanalization, because of limited collateral blood flow in the MCA territory in T-occlusion, the clinical outcome of mechanical thrombectomy in this lesion is unfavorable.<sup>2)6)8)</sup> Dual occlusion of the ACA and MCA may lead to unfavorable clinical outcomes despite successful recanalization of ACA and MCA occlusion.<sup>6)</sup>

Several methods can be considered when performing mechanical thrombectomy for dual lesions. After treating the MCA lesion, it remains uncertain whether the ACA lesion has been treated. Additionally, it is difficult to determine which lesion should be treated first.

We investigated the clinical and radiological outcomes of patients with dual occlusion ACA and MCA who underwent mechanical thrombectomy. In addition, we suggested a proper strategy for thrombectomy in simultaneous ACA and MCA occlusion.

## MATERIALS AND METHODS

### Study design

This retrospective study was approved by the Institutional Review Board of the Inje University, which included 280 patients with large artery occlusions treated with mechanical thrombectomy in our hospital from January 2018 to December 2020. Of these patients, 12 patients with simultaneous ACA and MCA occlusion who were treated with mechanical thrombectomy, including intra-arterial thrombolysis, were included in our study.

### Endovascular treatment

Most procedures are generally performed under local anesthesia via femoral access. A balloon-guiding catheter (BGC; 9F Optimo, Tokai Medical Products, Aichi,

Japan) was introduced into the proximal cervical internal carotid artery (ICA) as it was safely possible to arrest circulating blood flow.

After the occlusion lesion was confirmed by ICA angiography, the thrombus in the MCA was mostly removed by hybrid mechanical thrombectomy, as previously reported. Hybrid mechanical thrombectomy using catheter aspiration and stent retrievers simultaneously was performed as follows;<sup>5)</sup> 1) a stent (Trevo, Stryker Neurovascular, Fremont, CA, USA) was deployed to cover the entire thrombus burden; 2) subsequently, the intermediate catheter (Sofia 5F, Microvention, Aliso Viejo, CA, USA) was navigated to the proximal portion of the thrombus burden according to the deployed stent system; 3) proximal flow was arrested by a BGC, and 4) the intermediate catheter and stent were removed simultaneously under continuous negative pressure with a large syringe. The thrombus in the ACA was removed by stent retrieval using a partially deployed method or intra-arterial thrombolysis.<sup>1)</sup>

All patients underwent brain computed tomography (CT) to check for intracranial hemorrhage after endovascular treatment. The next day, CT angiography was performed to determine the patency of the occlusion lesion.

### Data collection

We collected the patients' clinical characteristics, treatment details, and clinical and radiological outcomes. The clinical characteristics included sex, age, and past medical history, including diabetes mellitus, hypertension, dyslipidemia, atrial fibrillation, and coronary artery occlusive disease.

The occlusion site was first classified as right or left. The occlusion lesion of MCA was classified as M1 to M4.<sup>9)</sup> The occlusion lesion of ACA was classified as A1 to A4.<sup>9)</sup> The National Institutes of Health Stroke Scale (NIHSS) was assessed on admission by duty-on neuro-interventionists or neurologists. The Alberta Stroke Program Early CT (ASPECT) score was evaluated on the initial brain CT by H. Lee. The symptom to hospital arrival time was defined as the time from stroke symptom onset to hospital arrival. The ICA size, A1 size, M1 size,

and angle between A1 and ICA were estimated in the anteroposterior (AP) view of the ICA angiogram by H. Lee.

The order of treatment was classified two groups; MCA group was first treated for MCA occlusion and later for ACA occlusion. ACA group was first treated for ACA occlusion and later for MCA occlusion.

The recanalization rate was assessed using thrombolysis in cerebral infarction (TICI) grade for each MCA and ACA lesion. Successful recanalization was defined as a TICI grade of 2b or 3. Clinical outcomes were evaluated using a 3-month mRS score. The mRS score was estimated by a neuro-interventionist or stroke neurologist during a routine clinical visit. A good clinical outcome was defined as an mRS score of 0–2.

### Statistical analysis

Baseline characteristics, such as the time from symptom onset to hospital arrival, NIHSS score at arrival, ASPECT score on initial brain CT, and anatomical characteristics of the intracranial vessel were analyzed using descriptive statistics. To compare the clinical outcomes between MCA group and ACA group, univariate analysis was performed using the Mann-Whitney U test. Also the clinical outcome according to occlusion size of ACA

(A1 or A2 group vs A3 or A4 group) was compared.

All statistical analyses were performed using SPSS version 25 (IBM Corp. Armonk, NY, USA). Statistical significance was set at  $p < 0.05$ .

## RESULTS

### Demographic data

A total of 280 patients underwent mechanical thrombectomy from January 2018 to December 2020, of whom 12 (4.3%) were eligible for ACA and MCA occlusion. Among the 12 patients, six (50%) were MCA group-first treated for MCA occlusion and later for ACA occlusion. Other patients were ACA group-first treated for ACA occlusion and later for MCA occlusion.

Table 1 presents the baseline characteristics of the patients. Of the 12 patients, six patients (50%) were male. The median age was 80 years (interquartile range, 66–85). Atrial fibrillation occurred in six (50%) patients. Other patients were newly diagnosed with atrial fibrillation. In five (41.7%) patients, the occlusion site was the right. The median NIHSS score at arrival hospital was 18 (interquartile range, 16–20).

**Table 1.** Baseline characteristic of patients

Case number	Sex/Age	Atrial fibrillation 1: past history 2: newly diagnosis	Symptom to hospital arrival (minute)	NIHSS score at arrival	ASPECT score in initial Brain CT
1	71/Male	1	37	7	7
2	80/Male	1	82	11	9
3	65/Male	2	45	18	9
4	48/Male	2	68	18	9
5	81/Female	1	45	17	8
6	67/Female	1	120	20	7
7	82/Male	2	37	20	10
8	50/Male	2	33	18	10
9	93/Female	2	544	16	4
10	80/Female	1	34	16	7
11	86/Female	2	803	21	8
12	86/Female	1	74	20	8
Median (Interquartile range)	80 (66-85)	-	56.5 (37-110.5)	18 (16-20)	8 (7-9)

NIHSS, National Institute of Health Stroke Scale; ASPECT, Alberta Stroke Programme Early CT; CT, computed tomography

The median symptom onset to hospital arrival time was approximately 56.5 min (interquartile range, 37-110.50). Two (16.7%) patients had over 6 h of symptom onset to hospital arrival time. Except for two patients, 10 (83.3%) patients underwent thrombectomy within 3 h of symptom onset.

Table 2 shows the occlusion site and anatomical characteristics of the intracranial vessels. M1 was the most common occlusion lesion (n=8). A3 was the most common lesion in the ACA (n=6). ICA was 5.26 mm, M1

was 3.91 mm, and A1 size was 3.25 mm. The median angle between ICA and A1 was 95.4°. The A1/M1 size ratio was determined to be 0.77.

Table 3 presents the procedural results. Successful recanalization of the MCA was achieved in 10 (83.3%) patients. Moreover, successful recanalization of the ACA was achieved in 10 (83.3%) patients. Successful recanalization of both ACA and MCA occlusion was observed in eight (66.7%) patients. Two (16.7%) patients underwent decompressive craniectomy after thrombectomy. Three

**Table 2.** Occlusion site and anatomy characteristic of intracranial vessel

Case number	Lesion	Occlusion lesion (MCA)	Occlusion lesion (ACA)	ICA size (mm)	M1 size (mm)	A1 size (mm)	A1/M1 ratio	Angle between A1 and ICA(°)
1	Right	M1	A3	5.31	4.32	2.68	0.62	82
2	Right	M1	A1	5.75	3.78	3.51	0.93	104
3	Right	M1	A3	5.24	4.46	3.22	0.72	104
4	Left	M1	A3	5.29	4.19	3.62	0.86	106
5	Right	M1	A3	5.62	4.03	3.05	0.76	85.0
6	Left	M2	A4	4.23	3.42	2.30	0.67	43
7	Left	M1	A2	5.24	4.44	3.44	0.77	90.7
8	Left	M2	A2	4.25	3.30	3.08	0.93	94.8
9	Right	M2	A3	5.27	3.79	3.61	0.95	95.9
10	Left	M3	A4	3.73	3.40	2.11	0.62	90.4
11	Left	M1	A2	6.55	4.31	3.27	0.76	99.1
12	Left	M1	A3	5.15	3.54	3.30	0.93	100.8
Median (Interquartile range)	-	-	-	5.26 (4.78-5.54)	3.91 (3.45-4.32)	3.25 (2.77-3.49)	0.77 (0.68-0.93)	95.4 (86.4-103.2)

MCA, middle cerebral artery; ACA, anterior cerebral artery; ICA, internal carotid artery

**Table 3.** Results of procedure

Case number	1st thrombectomy lesion	TICI (MCA)	TICI (ACA)	ICH	Decompressive craniectomy	3-m mRS
1	MCA	3	2b	0	0	3
2	MCA	3	2b	0	0	6
3	MCA	3	1	0	1	3
4	MCA	3	2b	0	0	2
5	MCA	3	2a	1	0	3
6	MCA	3	2b	0	0	2
7	ACA	2b	2b	0	0	4
8	ACA	1	2b	0	1	4
9	ACA	1	2b	1	0	5
10	ACA	3	2b	0	0	4
11	ACA	3	2b	1	0	6
12	ACA	3	3	0	0	2

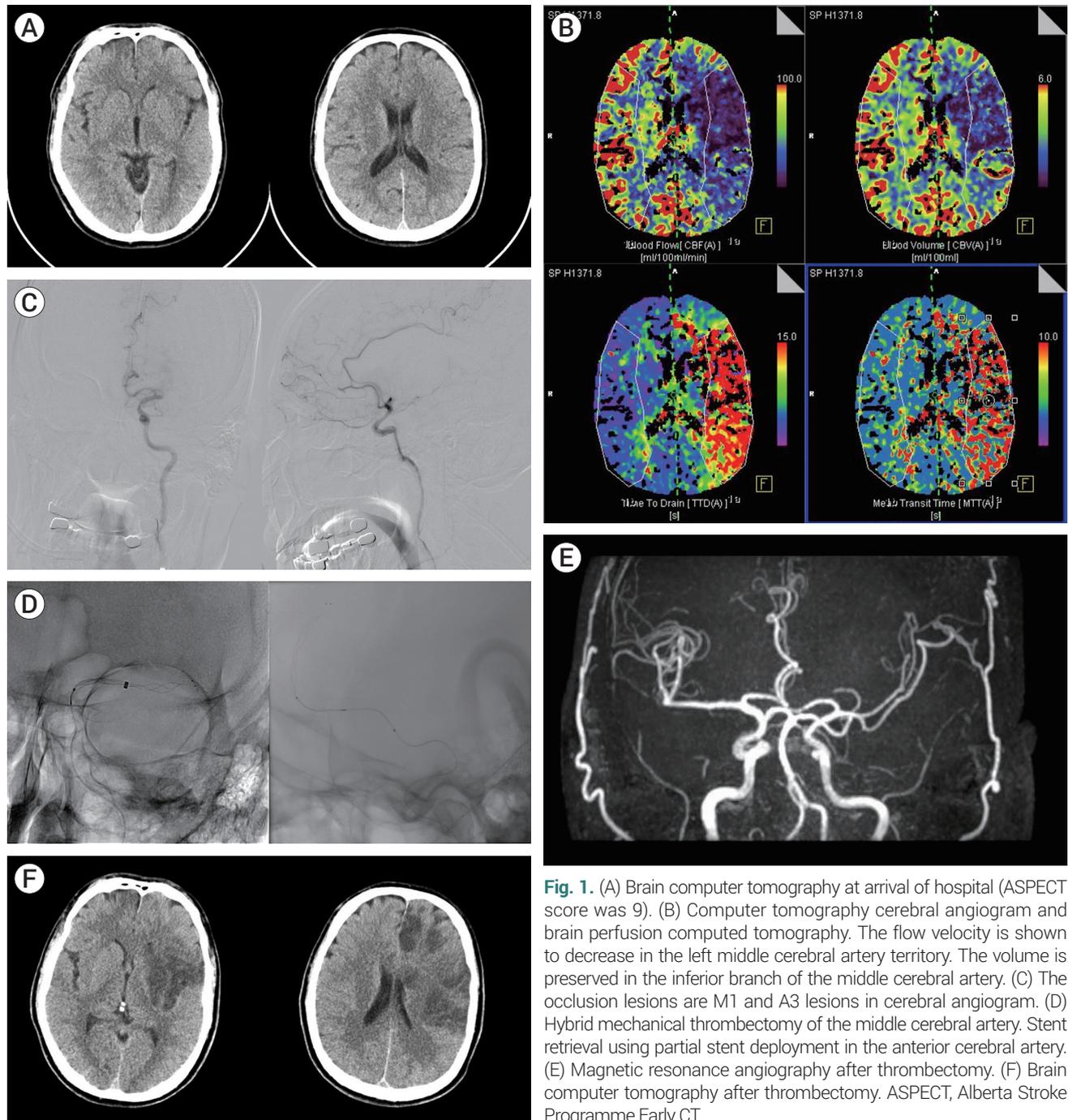
TICI, thrombolysis in cerebral infarction; MCA, middle cerebral artery; ACA, anterior cerebral artery; ICH, intracerebral hemorrhage; 3-m mRS, 3-month modified Rankin Scale

(25%) patients had good clinical outcomes (mRS  $\leq 2$ ), whereas two (16.7%) patients, who were over 6 h of symptom onset to the hospital arrival time, developed intracranial hemorrhage after thrombectomy, resulting in poor clinical outcomes. There was no difference in good clinical outcomes between the MCA and ACA groups (2 of 6 [33.3%] vs 1 of 6 [16.7%];  $p=0.180$ ). And

the clinical outcome of patients in A1 or A2 occlusion was worse clinical outcomes than the patients in A3 or A4 (0 of 4 [0%] vs 3 of 8 [37.5%];  $p=0.018$ ).

**The cases of good clinical outcome (Case number 4, Fig. 1)**

A 48-year-old male patient presented with right hemi-



**Fig. 1.** (A) Brain computer tomography at arrival of hospital (ASPECT score was 9). (B) Computer tomography cerebral angiogram and brain perfusion computed tomography. The flow velocity is shown to decrease in the left middle cerebral artery territory. The volume is preserved in the inferior branch of the middle cerebral artery. (C) The occlusion lesions are M1 and A3 lesions in cerebral angiogram. (D) Hybrid mechanical thrombectomy of the middle cerebral artery. Stent retrieval using partial stent deployment in the anterior cerebral artery. (E) Magnetic resonance angiography after thrombectomy. (F) Brain computer tomography after thrombectomy. ASPECT, Alberta Stroke Programme Early CT.

paresis (motor grade II) and motor aphasia within 68 min of symptom onset. The NIHSS score of the patients was 18 at arrival hospital, and the ASPECT score was nine on initial brain CT (Fig. 1-A). The mismatch between the blood flow and volume on perfusion CT was in the inferior division of the middle cerebral artery territory (Fig. 1-B). The occlusion lesions were M1 and A3 lesions (Fig. 1-C). M1 lesion was treated first using stent retrieval and catheter aspiration simultaneously. The A3 lesion was treated using stent retrieval (Fig. 1-D). After thrombectomy, the TICI scores of M1 and A3 were 3 and 2b, respectively (Fig. 1-E). However, low density in the left frontal region was observed on brain CT on the day 1 after thrombectomy (Fig. 1-F). After 3 months, the mRS score was 2. Independent walking was possible, but the right arm's motor was grade 4, and aphasia improved.

## DISCUSSION

In our series, successful recanalization of each ACA and MCA occlusion showed 83.3% and 83.3% respectively. However successful recanalization of both ACA and MCA occlusion was 66.7%. And the good clinical outcome of our series was 25%. It was no difference clinical outcome that according to the order of which lesion first treated in simultaneous ACA and MCA occlusions.

Most simultaneous ACA and MCA occlusions are caused by cardioembolism or artery-to-artery embolism.<sup>3,7)</sup> In our study, all patients were diagnosed with AF. We suggest that the evaluation of cardioembolism is important for simultaneous ACA and MCA occlusion.

In our study, the median NIHSS score at arrival was 18. The initial clinical symptoms were severe because the main collateral channel is poor in simultaneous MCA and ACA occlusion. The initial clinical severity of simultaneous MCA and ACA occlusion might lead to early arrival at the hospital (median time of symptom to hospital arrival: 56.6 min). Since the time from symptom development to the hospital was short, there was less change in initial brain CT (median ASPECT score: 8).

An embolus could be occluded in the ACA depending on the A1 size and A1/M1 size ratio.<sup>11)</sup> If the diameter of the ACA was large and the ACA was almost in a straight line with the ICA, the emboli could easily flow to the ACA. In this study, the A1 size was more than 3 mm, and it was similar to M1 size (A1 size: 3.25 mm vs M1 size: 3.91 mm). In addition, since ICA and A1 formed an angle of 95.4° in our study, emboli could easily flow to the ACA. This characteristic of ACA in simultaneous MCA and ACA occlusion allowed the microcatheter to easily access the lesion of the ACA, which led to recanalization successfully. In our results, the successful recanalization of the ACA was 83.3%.

The emboli that flowed into M1 and A1 were caught in the bifurcation in M1, and A2 or A3 were frequently occluded in our study. In MCA, M1 occlusion more frequently occurred than medium vessel occlusions such as M2 or M3 occlusions. However, medium vessel occlusion such as A2 or A3 occlusion usually occurred in the ACA. This indicated that the emboli in the MCA lesion were larger than those in the ACA lesion. The ACA occlusion site was determined by the emboli size that could be passed through A1. The larger the A1 size, the more occluded the proximal ACA.

Our results showed that the successful recanalization rates of ACA and MCA were 83.3% and 83.3%, respectively. However, the clinical outcome of our series was 25%. And especially, the clinical outcome was poor in the occlusion of proximal ACA such as A1 or A2. Because it was the insufficient collateral flow of MCA territory in simultaneous MCA and ACA occlusion, infarction could be progress rapidly. And the patients of large ACA infarction caused by proximal ACA occlusion had a severe disability with loss of leg's motor power and it worsen the modified Rankin Scale. Therefore, we believed that it was led to poor clinical outcomes despite successful recanalization of ACA and MCA after mechanical thrombectomy.

Additionally, no difference in clinical and radiological outcomes between the mechanical thrombectomy strategy was observed, in which ACA occlusion and MCA occlusion were treated first. We thought that the treat-

ment order was not important on the clinical outcome, because the successful recanalization rate was less effect on clinical outcome in simultaneous MCA and ACA occlusion. And in proximal ACA occlusion, it might be important to successful recanalization of ACA to reduce infarction area. However whether to treat ACA lesions according to the occlusion site of ACA would be necessary for further comparative study.

The small number of patients, retrospective design, and single-centered population are the main limitations of our study. And the bias had been had in statistical results, it caused by the small number of patients and the variable of treatment method.

Accordingly, a multi-centered study is required to evaluate the clinical and radiological outcomes in simultaneous ACA and MCA occlusions because of the rare incidence of simultaneous ACA and MCA occlusion.

## CONCLUSIONS

In our series, simultaneous ACA and MCA occlusion was mainly caused by cardioembolism and showed a poor clinical outcome despite the treatment with mechanical thrombectomy. The optimal treatment method was uncertain, it was needed to further study.

## Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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