Manual Aspiration Thrombectomy in Patients with Acute Stroke-Related Calcified Cerebral Emboli

Esther Koh, MD, Hyo Sung Kwak, MD, PhD, and Gyung-Ho Chung, MD, PhD

Objective: The aim of this study was to evaluate the effectiveness of mechanical aspiration thrombectomy (MAT) in patients with acute ischemic stroke from calcified cerebral emboli. *Methods:* Procedural results were reviewed for acute stroke patients with clinically neurological deficits who underwent recanalization from October 2012 through September 2015. Initial imaging studies and cerebral angiography were analyzed. *Results:* Of the total number of patients with acute stroke, 5 patients were confirmed to have acute ischemic stroke by calcified cerebral emboli. On initial brain computed tomographic imaging, all patients showed small, dense single calcifications in the middle cerebral artery with no definitive ischemic low-density lesions (M1: 3, M2: 2, mean size: 4.8 mm). All patients had angiographic findings of filling defects from calcified emboli. Four patients had good collateral flow and two had continuous distal flow. All patients underwent MAT using a Penumbra catheter (Penumbra Inc., Alameda, CA). MAT did not remove calcified emboli in all patients. Two patients with good collateral flow had favorable functional outcomes (modified Rankin Scale score ≤2). Four patients had diffuse calcification in the aortic arch, carotid artery, and aortic valve. *Conclusions:* Cerebral angiography supports a diagnosis of stroke when calcified cerebral emboli have contrast-filling defects and a degree of vascular occlusion. However, in this study, MAT was not an effective treatment for patients with calcified cerebral emboli because of hardness of the calcified plaque and packing into the arterial lumen.
Key Words: Stroke—calcified embolus—cerebral angiography—mechanical thrombectomy.
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Introduction

Calcified cerebral embolus is reported to be a cause of acute cerebral infarction. Although this condition is rare, identifying the embolic source is clinically important for proper treatment. Spontaneous calcified cerebral emboli occur more frequently than iatrogenic emboli, which may be caused by procedures such as cardiac catheterization that causes valve injury, cardiac massage, or chiropractic neck manipulation.[1-3] Proper identification can guide treatment to prevent future embolic events, neurological impairment, and death. Calcified cerebral emboli can be easily detected by noncontrast brain computed tomography (CT).[2,4] Although noncontrast CT is a good imaging modality for identifying calcification, calcified emboli are often misdiagnosed or ignored. Cerebral angiography is a confirmative diagnostic method for stroke. Cerebral emboli show as contrast-filling defects with or without delayed distal flow. Cerebral angiography is also performed for thrombolytic treatment or mechanical thrombectomy.

Several studies report controversial results for thrombolytic therapy for the immediate treatment of calcified embolic infarctions. The effectiveness of thrombolytic

From the Department of Radiology, Research Institute of Clinical Medicine of Chonbuk National University, Biomedical Research Institute of Chonbuk National University Hospital, Jeonju-si, Jeollabuk-do, Republic of Korea.

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Address correspondence to Hyo Sung Kwak, MD, PhD, Department of Radiology, Research Institute of Clinical Medicine of Chonbuk National University, Biomedical Research Institute of Chonbuk National University Hospital, 567 Baekje-daero, deokjin-gu, Jeonju-si, Jeollabuk-do, 561-756, Republic of Korea. E-mail: kwak8140@jbnu.ac.kr.

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therapy may be limited by the density of the calcified embolic lesions and the risk of hemorrhage.[5-7] Mechanical embolectomy is a treatment for vascular recanalization that can save time by instantly removing embolic material.[8] However, mechanical recanalization also has risks of cerebral complications such as vascular rupture and cerebral hemorrhage.[4] The purpose of the present study was to assess the location, size, shape, and source of calcified cerebral emboli and to evaluate the effectiveness of mechanical aspiration thrombectomy (MAT) in 5 patients.

Methods

The institutional review board approved the study. Consent for pharmacological or mechanical thrombolytic treatment was obtained from patients' legal representatives.

Between October 2012 and September 2015, we retrospectively reviewed noncontrast brain CT imaging of acute stroke patients in our hospital. Acute stroke patients were diagnosed with clinically neurological deficits using brain imaging such as CT, magnetic resonance imaging (MRI), and cerebral angiography. Five patients with acute cerebral infarction caused by calcified emboli were identified by initial brain CT. These patients had no clinical history of previous brain trauma or cerebral infarction. All patients were examined by initial CT at our hospital for evaluation of cerebral hemorrhage. On admission to the emergency center, the patients were assessed by a stroke neurologist using the National Institutes of Health Stroke Scale (NIHSS) score. The patients underwent cerebral angiography for MAT. We performed MAT using a Penumbra reperfusion catheter (Penumbra Inc., Alameda, CA).

Routine cerebral angiography was performed before treatment to evaluate collateral flow. An 8F introducer sheath (Super Arrow-Flex; Arrow International, Reading, PA) and an inner 100-cm-long 8F guide catheter (Guider Softip; Boston Scientific, Natick, MA) were placed in the common carotid artery to enable the approach of the Penumbra catheter. The Penumbra catheter was advanced until it reached the embolus. A 1.7F microcatheter was introduced coaxially beyond the occlusion and local angiography was performed to predict the original path of the occluded vessel and inspect the occlusion outline. We gently advanced the Penumbra catheter into the thrombus until it wedged tightly. Subsequently, the microcatheter and microguidewire were removed and a 20-mL syringe was connected to the proximal hub of the Penumbra catheter. Continuous manual aspiration was performed by maintaining a vacuum state between the tip of Penumbra catheter and the thrombus while gently withdrawing the Penumbra catheter through the guide catheter.

Potential calcified embolic sources were assessed by reviewing patients' medical records and all imaging. We also reviewed the success of mechanical recanalization. All patients underwent follow-up CT or MRI more than once. We reviewed medical records to collect demographic, clinical, and angiographic data. Degree of collateral flow was defined as good or poor according to visualization of the distal branch. NIHSS scores were measured on admission and at discharge, and modified Rankin scale (mRS) scores were checked on admission and at 3 months for all patients. A favorable outcome was defined as an mRS score of 2 or lower. The location, long-axis size, and shape of calcified emboli were analyzed.

Results

From October 2012 to September 2015, we performed cerebral angiography and endovascular treatment in approximately 450 acute stroke patients, including 193 with isolated middle cerebral artery (MCA) occlusion. Of the total number of patients with acute stroke, only 5 patients (1.1%) were diagnosed with calcified embolic stroke. During these periods, the successful recanalization rate by single Penumbra in patients with isolated MCA occlusion was 82.9%, and favorable clinical outcome (mRS score ≤2) was 60.0%.

Demographic, clinical, and angiographic findings in 5 patients are shown in Tables 1 and 2. Neurological examination of all patients revealed hemiparesis and mild-to-moderate dysarthria. The median NIHSS score at admission was 9 (range 8-16). On initial brain CT imaging,

Table 1. *Summary of patient demographics and clinical findings before and after recanalization therapy*

No.	Age (years)	Sex	Location	Side	Onset-to-door time (min)	Onset-to-needle time (min)	Procedure time (min)	IV-rtPA	Initial NIHSS score	Initial mRS score	NIHSS score at discharge	mRS score at 3 months
1	74	F	M2	Right	30	120	30	Y	9	4	2	1
2	35	M	M1	Left	60	120	25	Y	12	3	2	1
3	86	M	M1	Right	120	190	35	Y	8	4	6	3
4	37	F	M1	Left	240	290	30	N	15	4	15	4
5	77	M	M2	Left	30	60	25	Y	4	4	4	4

Abbreviations: F, female; IV, intravenous; M, male; mRS, modified Rankin Scale; N, no; NIHSS, National Institutes of Health Stroke Scale; rtPA, recombinant tissue plasminogen activator; Y, yes.

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