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# Detection of Thrombus in Acute Ischemic Stroke

## Value of Thin-Section Noncontrast-Computed Tomography

Eung Yeop Kim, MD; Seung-Koo Lee, MD; Dong Joon Kim, MD; Sang-Hyun Suh, MD;  
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**Background and Purpose**—Previous studies on the hyperdense middle cerebral artery (MCA) sign were conducted using  $\geq 5$ -mm thickness noncontrast-computed tomography (NCT). The purpose of this study was to compare thin-section NCT with 5-mm NCT in the detection of thrombus in acute ischemic stroke.

**Methods**—Enrolled were consecutive 51 patients with acute infarction in the anterior or MCA territory. All patients underwent both 5-mm NCT and either 1.25- or 1-mm thin-section helical NCT within 6 hours of symptom onset. Patients were assigned to either the single or multisegmental occlusion group, depending on the thrombus extent on thin-section NCT. Thin-section NCT and 5-mm NCT were compared in the detection of thrombi.

**Results**—Thrombi were identified in 45 patients (88%) on thin-section NCT and 16 on 5-mm NCT (31%;  $P < 0.001$ ). No occlusion was seen in 6 patients. Both sensitivity and specificity of thin-section NCT in detection of thrombus were 100%.

**Conclusions**—Acute thrombus can be detected with higher sensitivity on thin-section NCT than on 5-mm NCT, and its extent is more accurately determined on thin-section NCT. (*Stroke*. 2005;36:2745-2747.)

**Key Words:** acute stroke ■ cerebral infarct ■ neuroradiology ■ thrombosis

The hyperdense middle cerebral artery sign (HMCAS) is considered a marker of thrombus in the middle cerebral artery (MCA).<sup>1-3</sup> HMCAS is present in 5% to 50% of cases.<sup>2,4-6</sup> The specificity of HMCAS in identifying MCA occlusion approaches 100%, whereas its sensitivity is low.<sup>3,5</sup>

All previous studies on HMCAS were conducted using the conventional  $\geq 5$ -mm thickness noncontrast-computed tomography (NCT). We hypothesized that thin-section NCT would allow us to detect more thrombi. The purpose of our study was to compare thin-section NCT with conventional 5-mm NCT in the detection of thrombus in patients with acute ischemic stroke.

### Materials and Methods

Between April 2003 and March 2005, consecutive 51 patients (25 females, 26 males; mean age, 67 years) presented with infarction of the anterior or MCA territory. All of the patients underwent both 5-mm and either 1.25- or 1-mm thin-section NCT using 1 of 2 multidetector row CT scanners (LightSpeed Plus, GE Medical Systems; Sensation 16, Siemens Medical Systems). CT angiography (CTA) was subsequently obtained using the same thickness of either 1 or 1.25 mm. The maximum-intensity projection or curved-planar reformation images using source data were obtained by using a commercial 3-D software (Rapidia 2.8; Infinitt) if needed. Follow-up imaging was obtained using magnetic resonance imaging or NCT within 7 days after symptom onset.

Retrospectively, the occlusion of large arteries, including ICA, M1, M2, A1, and A2 segments, was determined by a neuroradiologist on CTA, including the source images of all patients. Two neuroradiologists who were not involved in determination of thrombus on CTA independently determined the presence of thrombus on both 5-mm and thin-section NCT images in a separate session. They were unaware of the follow-up images and of clinical information. Disagreements were decided by a consensus. Higher attenuation in the artery relative to the contralateral artery or to the adjacent parenchyma was considered a thrombus. Patients were assigned to either the single or multisegmental occlusion group according to thrombus extent on thin-section NCT. Two or more segmental occlusions were considered a multisegmental occlusion. Thrombus detection was compared between thin-section and 5-mm NCT using McNemar test.

### Results

Thrombi were identified on thin-section NCT in 45 patients (88%) and on 5-mm CT in 16 patients (31%;  $P < 0.001$ ; Figures 1 and 2). Occlusion sites on CTA were corresponded to the thrombi on thin-section NCT in these 45 patients. Interobserver agreements for detection of thrombi on thin-section and 5-mm NCT were all excellent ( $\kappa = 0.912$  and  $0.873$ , respectively). Six patients without thrombus on thin-section NCT did not show occlusions on CTA, but they showed infarction in the basal ganglia on the follow-up imaging. Therefore, sensitivity, specificity, and accuracy of thin-section NCT in

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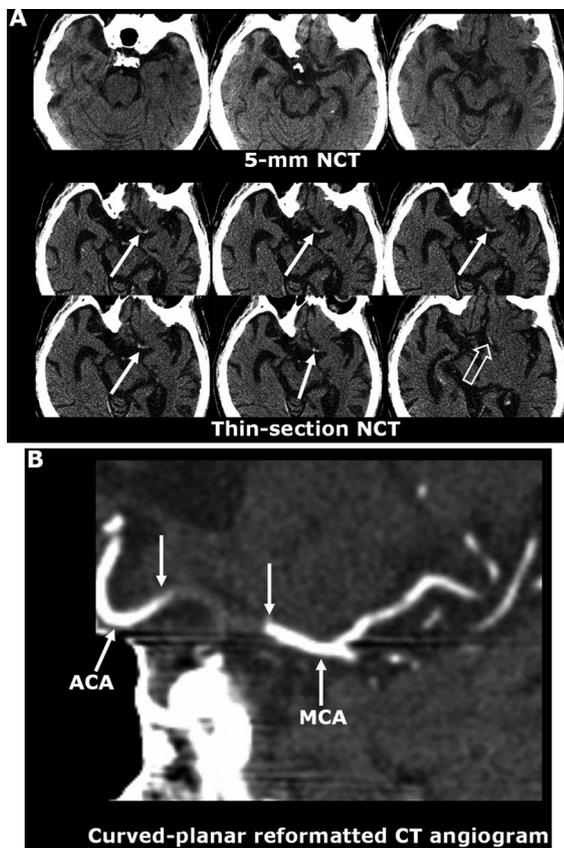
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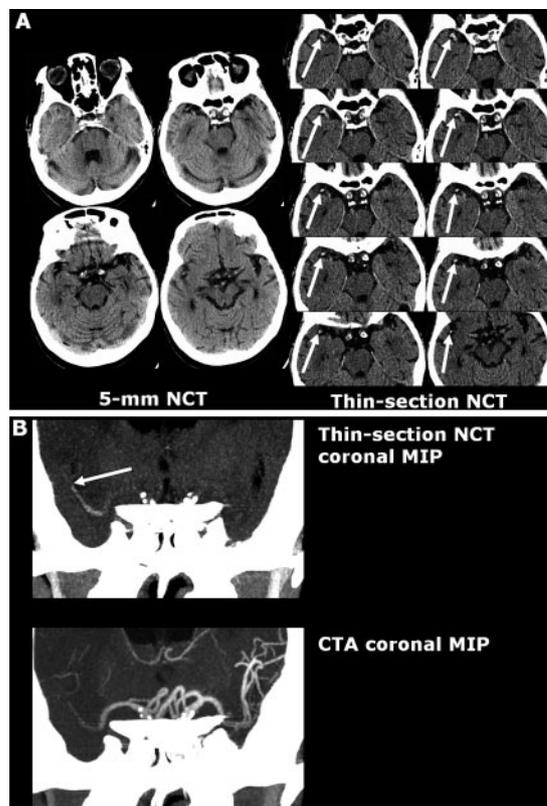
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**Figure 1.** An 81-y-old man presented with stuporous mentality 70 min after symptom onset. The initial 5-mm NCT shows no definite evidence of thrombus. Thin-section NCT, however, clearly demonstrates high-attenuation lesions in the distal internal carotid artery and M1 segment on the left, indicative of thrombi (arrows on A). Also seen is a thrombus in the left A1 segment (open arrow on A). Curved-planar reformatted CT angiogram shows occlusions at both the A1 and M1 segments (arrows on B).

detection of thrombi were all 100%. On the other hand, sensitivity, specificity, and accuracy of 5-mm NCT were 36%, 100%, and 43%, respectively.

Single and multisegmental occlusions on thin-section NCT were seen in 25 and 20 patients, respectively, whereas they were noted on 5-mm NCT in 13 and 3 patients, respectively ( $P < 0.001$ ; Table).



**Figure 2.** A 79-y-old woman presented with left-sided weakness 90 min after symptom onset. The initial 5-mm NCT shows no definite evidence of thrombus (A). Thin-section NCT, however, obviously demonstrates high-attenuation lesions in the right distal M1 segment and the proximal M2 segment (arrows on A). MIP of thin-section NCT reveals the distal end of the thrombus (arrow on B).

### Discussion

The HMCAS is highly specific for MCA occlusions, helping physicians to determine eligibility for thrombolysis. Therefore, accurate and early detection of the HMCAS is important for the management of acute ischemic stroke. However, the HMCAS is limited because of its low sensitivity. Previous studies have used 5-mm or more thickness NCT, which may be insufficient to delineate a small thrombus in a nonlinear artery. Thin-section NCT in this study could overcome this limitation and was superior to 5-mm CT in terms of thrombus detection.

In this study, the extent of thrombus could be more accurately determined on thin-section NCT. Thrombus extent may have

#### Comparison of 5-mm and Thin-Section NCT in Detection of Thrombi by Vessel Location (n=51)

Vessel Location	Occlusion on CTA	5-mm NCT				Thin-Section NCT			
		Thrombus Presence	Sensitivity, %	Specificity, %	Accuracy, %	Thrombus Presence	Sensitivity, %	Specificity, %	Accuracy, %
Distal ICA	9	3	33	100	97	9	100	100	100
M1	29	8	28	100	79	29	100	100	100
M2	25	7	28	100	82	25	100	100	100
A1	4	0	0	100	96	4	100	100	100
A2	2	0	0	100	98	2	100	100	100
All, n=510	69	18	26	100	50	69*	100	100	100

\* $P < 0.001$ . CTA indicates CT angiogram; ICA, internal carotid artery.

therapeutic implications because a larger thrombus causing multisegmental occlusion may require a longer time for thrombolysis than a smaller thrombus, resulting in severe ischemia. In addition, fewer thrombolytic agents may be required for a smaller thrombus. However, further prospective studies using dose modulation of thrombolytics according to thrombus extent should be conducted.

In conclusion, acute thrombus can be detected with higher sensitivity on thin-section NCT than on 5-mm NCT, and its extent is more accurately determined on thin-section NCT.

### References

1. Gacs G, Fox AJ, Barnett HJ, Vinuela F. CT visualization of intracranial arterial thromboembolism. *Stroke*. 1983;14:756–762.
2. Leys D, Pruvo JP, Godefroy O, Rondepierre P, Leclerc X. Prevalence and significance of hyperdense middle cerebral artery in acute stroke. *Stroke*. 1992;23:317–324.
3. von Kummer R, Meyding-Lamade U, Forsting M, Rosin L, Rieke K, Hacke W, Sartor K. Sensitivity and prognostic value of early CT in occlusion of the middle cerebral artery trunk. *AJNR Am J Neuroradiol*. 1994;15:9–15; discussion 16–18.
4. Tomsick T, Brott T, Barsan W, Broderick J, Haley EC, Spilker J. Thrombus localization with emergency cerebral CT. *AJNR Am J Neuroradiol*. 1992;13:257–263.
5. Manelfe C, Larrue V, von Kummer R, Bozzao L, Ringleb P, Bastianello S, Iweins F, Lesaffre E. Association of hyperdense middle cerebral artery sign with clinical outcome in patients treated with tissue plasminogen activator. *Stroke*. 1999;30:769–772.
6. Barber PA, Demchuk AM, Hudon ME, Pexman JH, Hill MD, Buchan AM. Hyperdense Sylvian fissure MCA ‘dot’ sign: a CT marker of acute ischemia. *Stroke*. 2001;32:84–88.