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# Early signs of middle cerebral artery infarction on multidetector computed tomography: Review of 20 cases

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## Abstract:

**OBJECTIVE:** This study intended to assess the occurrence of early signs of middle cerebral artery (MCA) on multidetector computed tomography (MDCT) in correlation with duration of the clinical features of stroke.

**PATIENTS AND METHODS:** This retrospective study analyzed the electronic records of 20 patients with MCA infarction. The detected signs studied according to the onset of the clinical features of stroke to the time of CT imaging.

**RESULTS:** Out of 20 patients with MCA infarction included in this study, the results revealed a significant relationship between the presence of insular ribbon sign and/or subtle hypodensity and hyperacute infarction ( $P < 0.001$  and  $0.003$ , respectively). Results revealed significant relationship between the occurrence of hypodense area, effacement of the cortical sulci, and compression of the ipsilateral lateral ventricle with acute infarction (6–72 h), ( $P = 0.006$ ,  $0.007$ , and  $0.002$ ) (odds ratio =  $0.047$ ,  $0.050$  and  $0.028$ ) and (95% confidence interval =  $0.004$ – $0.552$ ,  $0.004$ – $0.597$  and  $0.002$ – $0.367$ ) respectively.

**CONCLUSION:** MDCT can detect nearly half of MCA infarctions in the first 6 h. Insular ribbon sign and subtle hypodensity were the most significant findings in the first 6 h of stroke. Hypodense area was a significant sign after 6 h. Diabetes mellitus and ischemic heart disease were the most common risk factors. Hemiparesis was the most common clinical finding in MCA infarction.

## Keywords:

Early signs, middle cerebral artery infarction, multidetector computed tomography

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## Introduction

Brain infarction is irreversible damage to the brain tissue due to inadequate blood supply to the brain tissue because of occlusion of main cerebral artery either by thrombus or embolism. Stroke is a significant cause of death worldwide and a significant cause of long-term disability even in developed countries. Ischemic stroke (Infarction) is the majority (approximately 85%) of cerebral stroke.<sup>[1]</sup>

Cerebral infarction affects left cerebral hemisphere more than the right and most

commonly affects the middle cerebral artery (MCA).<sup>[2]</sup> The incidence was reported to be higher in males than females before 85 years old.<sup>[3]</sup> Subclinical brain infarction affects nearly fifth of the stroke-free elderly population and significantly increases the risk of future stroke.<sup>[4]</sup>

Brain imaging has a significant role in early diagnosis, confirmation of brain infarction, and exclusion of hemorrhagic stroke. Computed tomography (CT) can usually detect signs of hyperacute infarction (<6 h), but it appears healthy in nearly 30% of cases.<sup>[5]</sup>

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Early signs of brain infarction are hyperdense MCA sign, loss of insular ribbon, loss of the gray-white matter junction, effacement of the cortical sulci, subtle hypodensity in the cerebral tissue, parenchymal hypodensity, cerebral edema with compression of the ipsilateral lateral ventricle, and midline shift.<sup>[6]</sup>

Noncontrast CT remains the primary imaging modality for evaluation of patients with clinical features of acute stroke.<sup>[7]</sup>

This study aims to assess the detection rate of the early signs of MCA infarction on multidetector CT (MDCT) imaging in the first 3 days and to correlate between the time of occurrence of each sign on CT scan and the phase of infarction. This study is significant to highlight the role of MDCT imaging modality in the diagnosis of infarction in the first 6 h that is a critical time to avoid irreversible damage to the brain.

## Patients and Methods

This was a cross-sectional retrospective study that involves 20 cases of hyperacute and acute brain infarction. The data were collected from the preserved electronic files in the hospital. All the patients underwent imaging of the brain by CT in the period from April 2017 to April 2018. Inclusion criteria were as follows: (1) patients with available time between first complaining and imaging, (2) patients with hyperacute and acute infarction, and (3) patients with a confirmed diagnosis. Exclusion criteria were as follows: (1) patients with infarction but no available full history, (2) patients with subacute infarction (older than three days), (3) patients with chronic infarction (older than two weeks), (4) patients with hemorrhagic stroke, (4) patients with brain neoplasms or other pathologies, and (5) patients with normal brain CT. We compared the occurrence of the early signs of MCA in acute and subacute phases.

All the selected cases were reported by a high-qualified radiologist with 4 years' postdoctorate experience in CT imaging. Another high-qualified radiologist independently reported all the selected cases again to decrease the interobserver variance.

## Ethics

Institutional ethical approval was obtained for this study. Data were collected from the preserved CT reports of the patients. Confidentiality of the patient's personal information was taken in mind.

## Procedure

A 64-slice multidetector siemens CT machine was used in imaging all of the patients. The patients scanned

according to the acute stroke CT protocol of brain imaging.<sup>[8]</sup>

## Statistical analysis

Data were analyzed by the Statistical Package for the Social Sciences (SPSS), IBM, SPSS, version 23, USA. Descriptive statistics was reported as frequencies and percentages. Chi-square test and multivariate logistic regression were performed to describe the relationship between the variables.

## Results

A total of 20 patients underwent CT imaging of the brain; age ranges from 10 years to 95 years (the mean age = 57.75 years). Males were affected more than females (13 [65%] vs. 7 [35%]). There was no significant difference between the affected sides of the brain (55% right vs. 45% left) as shown in Table 1.

Exactly 45% of cases detected in the first 6 h (hyperacute stage) and 55% detected from 6 h to 3 days after the attack of stroke as demonstrated in Table 2.

Correlation between the stage of infarction and signs on CT scan revealed a significant relationship between the phase of infarction and insular ribbon sign, subtle hypodensity, hypodense area, effacement of the cortical sulci, and compression of the ipsilateral lateral ventricle ( $P = 0.001, 0.003, 0.006, 0.007, \text{ and } 0.002$ , respectively)– [Table 3].

Table 4 revealed that diabetes mellitus (DM), ischemic heart disease (IHD), and hypertension (HTN) were risk factors in 10%, 10%, and 5% of the patients, respectively. Most cases (70%) had no obvious risk factors. All cases of MCA infarction presented with hemiparesis, 15% with facial palsy, 15% with aphasia or dysarthria, and only 5% with sudden blindness as shown in Figure 1.

**Table 1: Gender of the involved patients and the affected side of the brain**

Variables	Parameters	Frequency (%)	P
Gender	Male	13 (65)	0.18
	Female	7 (35)	
Affected side	Right	11 (55)	0.655
	Left	9 (45)	

**Table 2: Duration of clinical features of infarction before computed tomography imaging of the brain**

Period from beginning of the stroke signs	Frequency (%)
Hyperacute (<6 h)	9 (45)
Acute (6-72 h)	11 (55)
Total	20 (100.0)

**Table 3: Correlation between the occurrence of signs of MCA infarction on MDCT and the stage of infarction**

Sign of infarction	Stage of infarction	Positive, n (%)	Negative, n (%)	Nonapplicable, n (%)	Total, n (%)	Significance	P
Hyperdense MCA sign	Hyperacute	5 (55.6)	4 (44.4)	0 (0.0)	9 (100)	No	0.423
	Acute	8 (72.7)	3 (27.3)	0 (0.0)	11 (100)		
Insular ribbon sign	Hyperacute	3 (33.3)	5 (55.6)	1 (11.1)	9 (100)	Positive	0.001
	Acute	1 (9.1)	0 (0.0)	10 (90.9)	11 (100)		
Hypodense area	Hyperacute	1 (11.1)	8 (88.9)	0 (0.0)	9 (100)	Positive	0.006
	Acute	8 (72.7)	3 (27.3)	0 (0.0)	11 (100)		
Subtle hypodensity	Hyperacute	5 (55.6)	3 (33.3)	1 (11.1)	9 (100)	Positive	0.003
	Acute	0 (0.0)	2 (18.2)	9 (81.8)	11 (100)		
Loss of GM/WM interface	Hyperacute	1 (5%)	8 (40)	0 (0.0)	9 (40)	No	0.275
	Acute	0 (0.0)	11 (55)	0 (0.0)	11 (55)		
Effacement sulci	Hyperacute	3 (33.3)	6 (66.7)	0 (0.0)	9 (100)	Positive	0.007
	Acute	10 (90.9)	1 (11.1)	0 (0.0)	11 (100)		
Compression of ventricle	Hyperacute	1 (11.1)	8 (88.9)	0 (0.0)	9 (100)	Positive	0.002
	Acute	9 (81.8)	2 (18.2)	0 (0.0)	11 (100)		
Shifting midline	Hyperacute	1 (11.1)	8 (88.9)	0 (0.0)	9 (100)	No	0.194
	Acute	4 (36.4)	7 (63.6)	0 (0.0)	11 (100)		

The table revealed a significant relationship between the stage of infarction and insular ribbon sign, hypodense area, and subtle hypodensity, effacement of the cortical sulci and compression of the ipsilateral lateral ventricle. No significant relationship between the stage of infarction and hyperdense MCA sign, loss of GM/WM interface or shifting of the midline. MCA: Middle cerebral artery, GM: Grey matter, WM: White matter

**Table 4: Risk factors in patients with early middle cerebral artery infarctions**

Risk factor	Number and percentage of patients, n (%)	Notes
No obvious risk factors	14 (70)	Most cases
DM, IHD, HTN	2 (10)	Multiple risk factors
DM, HTN	1 (5)	Multiple risk factors
DM, IHD	1 (5)	Multiple risk factors
IHD	1 (5)	Single risk
RHD (MS and AR)	1 (5)	Single risk

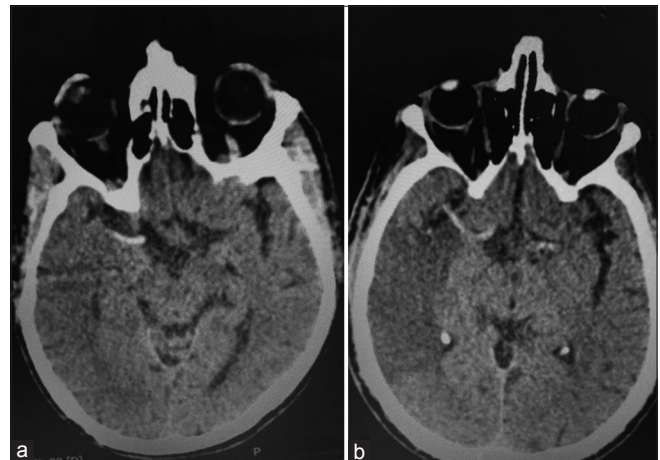
DM: Diabetes mellitus, IHD: Ischemic heart disease, HTN: Hypertension, RHD: Rheumatic heart disease, MS: Mitral stenosis, AR: Aortic regurgitation

## Discussion

Early diagnosis of MCA infarction is a critical point for management to avoid severe complications and persistent handicap. This study focused on the role of MDCT scan in the detection of the early signs of MCA infarction in hyperacute and acute stages.

In this study, hyperdense MCA sign was positive in 55.6% of cases in the first 6 h and 72.7% from 6 to 72 h. This was reported by Abd Elkhalek *et al.*, as an accurate early sign for the diagnosis of MCA infarction with 100% sensitivity and 60% specificity.<sup>[9]</sup> However; this sign appeared in both hyperacute and acute infarction without significant difference. Chavhan and Shroff reported that hyperdense MCA sign occurs with the 2<sup>nd</sup> h from the onset of symptoms of stroke.<sup>[10]</sup>

The insular ribbon sign was observed as a reflection of edema in early infarction in 20% of cases of this study. It was significantly related to the hyperacute phase of infarction (within the first 6 h). This result was consistent



**Figure 1:** Noncontrast computed tomography images of different patients show (a) hyperdense middle cerebral artery signs in a patient with right middle cerebral artery hyperacute infarction. (b) hyperdense middle cerebral artery sign with obvious hypodense area in the territory of the right middle cerebral artery in an acute right middle cerebral artery infarction

with Sarikaya and Provenzale, who reported that insular ribbon sign occurred in 70% of cases at 2 h and occurred in 77% at 3 h after onset symptoms of stroke.<sup>[11]</sup>

Hypodense area on CT scan was occurred predominantly after 6 h (acute phase) in this study. It revealed a significant association with acute stroke rather than hyperacute. Consistently, Sarikaya and Provenzale reported this sign in 53% of cases at 6 h.<sup>[11]</sup> Another previous study by Aronovich *et al.* stated cerebral tissue hypodensity in the majority of patients in early ischemic stroke.<sup>[12]</sup>

In the current study, subtle hypodensity of cerebral tissue was detected in the first 6 h in 55.6% of cases and not discovered after 6 h. This sign is a significant

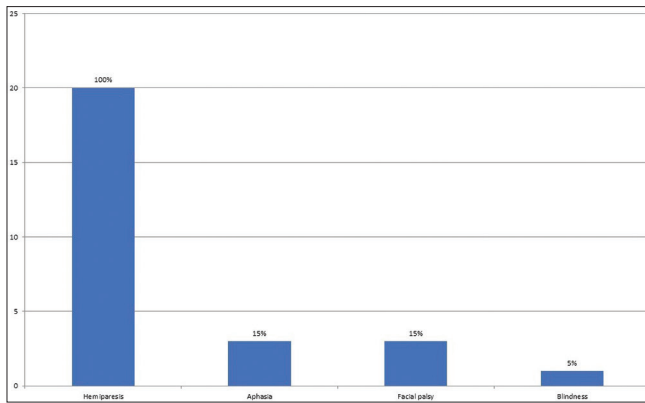


Figure 2: The clinical features of the patients with MCA

predictor of hyperacute MCA infarction as reported by von Kummer *et al.*<sup>[13]</sup>

The effacement of cortical sulci and loss of gray-white matter interface were common CT findings in acute and hyperacute infarction. The current study observed that effacement of cortical sulci was more evident with increasing duration from the onset of stroke. Thus, it is more common in after 6 h than before. Similar to these findings, Nakano *et al.* reported that effacement of cortical sulci was an advanced sign of infarction and a predictor of hemorrhagic transformation.<sup>[14]</sup>

Compression of lateral ventricles and shifting of the midline were signs of early infarction because of cerebral edema. In this study, these signs were predominant after 6 h than before. In contrast to this study, Dostovic *et al.* reported cerebral edema only in 7.9% of acute cerebral infarction.<sup>[15]</sup>

In this study, four patients had more than one risk factor, and the most common risk factor was DM than IHD and HTN. These results are not compatible with Safeer *et al.*, who reported that HTN was the most common risk factor.<sup>[16]</sup>

All patients in our study were presented with hemiparesis [Figure 2]. This result is consistent with Heiss, who reported that hemiparesis was the most clinical feature in malignant MCA infarction.<sup>[17]</sup>

Regarding clinical features, all patients included in this study presented with sudden onset hemiparesis, only 15% of patients associated with either aphasia/dysarthria or facial palsy. These results are nearly similar to a previous study by Yew and Cheng (2009), who reported that 96% of ischemic stroke presented with sudden onset clinical features. They reported arm weakness in 63% and leg weakness in 54% of ischemic cases in their study.<sup>[18]</sup>

### Limitations of this study

This study was limited by the following: (1) the sample size was not large enough and (2) the retrospective nature of the study that did not permit to follow up of the patients and record the physiopathological threshold and related pathological changes of each patient that is another parameter affecting the CT appearance of infarction.

### Conclusion

MDCT can detect nearly half of MCA infarctions in the first 6 h. Insular ribbon sign and subtle hypodensity were significant findings in the first 6 h of the cerebral ischemic stroke. Hypodense area was a significant sign after 6 h. Hyperdense MCA sign is an essential sign in both hyperacute and acute phases of MCA infarction. DM and IHD were the most common risk factors. Hemiparesis was the most common clinical finding in MCA infarction.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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