Hypodensity of $\frac{1}{3}$ Middle Cerebral Artery Territory Versus Alberta Stroke Programme Early CT Score (ASPECTS)

Comparison of Two Methods of Quantitative Evaluation of Early CT Changes in Hyperacute Ischemic Stroke in the Community Setting

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Background—The one third middle cerebral artery territory ($\frac{1}{3}$ MCA) method and the Alberta Stroke Program Early CT Score (ASPECTS) were used to detect significant early ischemic changes (EIC) on CT brain of acute stroke patients. We sought to compare the reliability of the 2 methods in routine clinical practice.

Methods—Eighty consecutive patients admitted to a community hospital in Hong Kong with suspected acute ischemic stroke and a CT brain scan performed within 6 hours of symptom onset were included. Five blinded observers (1 neurologist, 2 general radiologists, and 2 neuroradiologists) independently evaluated the scans, using the ATLAN-TIS/CT Summit criteria for $\frac{1}{3}$ MCA involvement, and ASPECTS $\leq 7$. Kappa statistics were used to determine interobserver agreement.

Results—Significant EIC were present in 11.4% of the scans with the $\frac{1}{3}$ MCA method, and 19.4% with ASPECTS. For $\frac{1}{3}$ MCA involvement, all observers agreed in 57 cases (71%), with moderate interobserver agreement ($\kappa = 0.49$). For ASPECTS $\leq 7$, all observers agreed in 34 cases (42%), with fair interobserver agreement ($\kappa = 0.34$). After prevalence and bias adjustments, substantial (prevalence-adjusted bias-adjusted $\kappa = 0.74$) and moderate (PABAK = 0.44) agreements were found for the $\frac{1}{3}$ MCA method and ASPECTS respectively.

Conclusions—The $\frac{1}{3}$ MCA method was more reliable in detecting significant EIC on CT brain within 6 hours of stroke onset in routine clinical practice, whereas ASPECTS was able to detect significant EIC in a higher proportion of these early scans. (Stroke. 2003;34:1194-1196.)

Key Words: cerebral infarction ■ computed tomography ■ thrombolysis

The one third middle cerebral artery territory ($\frac{1}{3}$ MCA) method is commonly used to quantify early ischemic changes (EIC) on CT brain scans of acute stroke patients, as hypointensity in $\frac{1}{3}$ MCA territory was associated with worsened outcome after thrombolytic therapy. More recently, the Alberta Stroke Program Early CT Score (ASPECTS) was proposed as an alternative method, with ASPECTS $\leq 7$ found to predict poor outcome and symptomatic hemorrhage better than the $\frac{1}{3}$ MCA criterion in patients treated with intravenous recombinant tissue plasminogen activator within 3 hours of stroke onset. However, the reliability of the $\frac{1}{3}$ MCA method has been controversial, and both methods have not been previously evaluated in routine clinical practice.

In this study, we aimed to compare the interobserver agreement of these 2 methods of EIC quantification in the community setting.

Subjects and Methods

All patients admitted to a community hospital in Hong Kong during the 12-month period in 2000 with suspected acute ischemic stroke and a noncontrast CT brain performed within 6 hours of symptom onset were recruited. The study coordinator (H.K.F.M.) determined their final diagnoses after consideration of all clinical and radiological data.

The acute CT brain scans of 80 patients, out of a total of 175 patients identified, were used in the study. Excluded patients were as follows: 62 with intracranial hemorrhages (all easily identifiable on the scans), 21 with uncertainty in the presence of individual early CT
signs (the proportion of scans with significant EIC in this group was similar to that of the study group), 4 with uncertain time of stroke onset, and 8 with poor scan quality.

All CT scans were performed on a fourth-generation scanner (PQ 2000, Picker International Inc) with orbitomeatal line positioning; scan area from foramen magnum to skull vertex; section thickness 5 mm in the posterior fossa and 10 mm in the rest of the brain; and scanning parameters kV=130, mA=200, scan time=1.5 seconds, mA=300. Routine photography was done at window level and width 40 HU and 150 to 200 HU, respectively, in the posterior fossa, and 40 HU and 80 to 100 HU, respectively, in the supratentorial compartment.

Five readers of different specialties (1 neurologist, 2 general radiologists, and 2 neuroradiologists) independently evaluated the original films of all 80 scans on a viewing box, with only minimal clinical histories (eg, the side of weakness). A standard worksheet was used, on which the readers scored in sequence: (1) presence or absence of 6 early CT signs (to be reported separately); (2) determination of $>\frac{1}{3}$ MCA versus $\leq\frac{1}{3}$ MCA territory involvement using the worksheet derived from the ATLANTIS/CT Summit criteria; and (3) determination of ASPECTS $\leq 7$ versus $> 7$ using the ASPECTS study form.

The readers were given only brief training, which included a set of written guidelines based on relevant published articles and a 30-minute individual briefing by the study coordinator with 5 separate CT films (2 with extensive EIC) as shown examples. In addition, observers 1 and 2 evaluated 30 of the 80 scans separately without any clinical information, prior to their viewing sessions when brief histories were provided.

The average prevalence of significant EIC and percentage agreement among the 5 readers using the 2 CT methods were determined. Pairwise kappa values ($\kappa$) were computed for interobserver agreement, classified as poor ($<0.01$), slight ($0.01$ to $0.20$), fair ($0.21$ to $0.40$), moderate ($0.41$ to $0.60$), substantial ($0.61$ to $0.80$), or almost perfect ($0.81$ to $1.00$). As prevalence and bias may significantly affect $\kappa$, the prevalence-adjusted bias-adjusted $\kappa$ (PABAK) values were also determined.

## Results

The study sample consisted of 46 males and 34 females; mean age was 69 years (SD ± 13 years). Final diagnoses were acute ischemic stroke in 38 (47.5%, 33 nonlacunar and 5 lacunar), transient ischemic attack in 26 (32.5%), and non-stroke conditions in 16 (20%).

Significant EIC were detected in 11.4% (SD=5.3%, range 7.5% to 25%) of the scans with the $>\frac{1}{3}$ MCA criterion and in 19.4% (SD=13.8%, range 7.5% to 47.5%) with ASPECTS $\leq 7$.

Perfect agreement on $>\frac{1}{3}$ versus $\leq\frac{1}{3}$ MCA involvement and on ASPECTS $\leq 7$ versus $> 7$ were 71% (66% + 5%) and 42% (36% + 6%), respectively (Table 1). For determination of $>\frac{1}{3}$ MCA involvement, interobserver agreement was only moderate ($\kappa=0.49$) with pairwise $\kappa$ but improved to substantial (PABAK=0.74) after prevalence and bias adjustments. For determination of ASPECTS $\leq 7$, $\kappa$ and PABAK were 0.34 and 0.44 respectively, representing fair and moderate agreement (Table 2).

Agreement between blinded and nonblinded readings in both methods were substantial to almost perfect in observers 1 and 2 ($\kappa=0.76$ to 0.84), implying that the availability of brief clinical history did not significantly affect reading with the 2 CT methods.

## Discussion

Previous validation studies on the 2 CT methods involved patient populations who either participated in acute stroke trials or received intravenous recombinant tissue plasminogen activator within a 3-hour time window. Our study would provide complementary information on the reliability of the 2 CT methods among physicians from different backgrounds in community practice.

### Table 1. Overall Agreement (%) Among Raters in the 2 CT Methods

<table>
<thead>
<tr>
<th>Observer Pair</th>
<th>$&gt;\frac{1}{3}$ MCA</th>
<th>ASPECTS $\leq 7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 versus 2</td>
<td>0.72</td>
<td>0.67</td>
</tr>
<tr>
<td>1 versus 3</td>
<td>0.38</td>
<td>0.14</td>
</tr>
<tr>
<td>1 versus 4</td>
<td>0.39</td>
<td>0.24</td>
</tr>
<tr>
<td>1 versus 5</td>
<td>0.78</td>
<td>0.51</td>
</tr>
<tr>
<td>2 versus 3</td>
<td>0.47</td>
<td>0.16</td>
</tr>
<tr>
<td>2 versus 4</td>
<td>0.44</td>
<td>0.36</td>
</tr>
<tr>
<td>2 versus 5</td>
<td>0.58</td>
<td>0.44</td>
</tr>
<tr>
<td>3 versus 4</td>
<td>0.31</td>
<td>0.26</td>
</tr>
<tr>
<td>3 versus 5</td>
<td>0.4</td>
<td>0.18</td>
</tr>
<tr>
<td>4 versus 5</td>
<td>0.47</td>
<td>0.4</td>
</tr>
<tr>
<td>Average</td>
<td>0.49</td>
<td>0.34</td>
</tr>
</tbody>
</table>

*PABAK: prevalence-adjusted bias-adjusted kappa.
In conclusion, we found that in routine clinical practice when the prevalence of extensive EIC on the CT brain scans among stroke patients is low (10% to 20%), the \( \frac{1}{3} \) MCA method is robust and more reliable compared with ASPECTS. However, ASPECTS has potential in detecting more subtle early CT changes in hyperacute stroke, as its use resulted in a higher prevalence of significant EIC.

### References


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Stroke. 2003;34:1194-1196; originally published online April 10, 2003;
doi: 10.1161/01.STR.0000069162.64966.71

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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