Automated CT Perfusion in Acute Ischemic Stroke: Pearls and Pitfalls

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Objectives:
1) To identify pitfalls of Automated CT Perfusion (CTP) in patients with acute ischemic stroke
2) To learn practical pearls for accurate diagnosis of CT Perfusion

Disclosures: None
### CTP Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measures</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral Blood volume (CBV)</td>
<td>Volume of blood within a voxel</td>
<td>ml/100g</td>
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<tr>
<td>Cerebral Blood Flow (CBF)</td>
<td>Volume of blood traversing a voxel per unit time</td>
<td>ml/100g/min</td>
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<tr>
<td>Mean Transit Time (MTT)</td>
<td>Average transit time of contrast bolus through a given volume of brain</td>
<td>seconds</td>
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<tr>
<td>Time to maximum (Tmax)</td>
<td>Time from arterial peak to tissue peak after deconvolution</td>
<td>seconds</td>
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\[ CBF = \frac{CBV}{MTT} \]

### Potential Sources of Misclassification Error

- **Underestimation of Core Infarct**
  - Cerebral Blood Flow (CBF) threshold
  - Luxury Perfusion
  - Small/Lacunar Infarct

- **Overestimation of Penumbra**
  - Upstream Vessel Stenosis
  - Skull base artifact
  - Head tilt/motion
  - Normal vascular variant
  - Encephalomalacia
Underestimation of Core Infarct

(a) Loss of grey white differentiation (arrows) indicative of infarction. (b) However, on CTP images, using the CBF threshold of <30%, there is no core infarct present. (c) MRI showing acute infarct.

(a) In a different patient, areas of hypoattenuation are seen (arrows) representing areas of lacunar infarction. (b) The infarction adjacent to the anterior horn is not seen using a threshold of CBF <30%, only detected using a threshold of CBF <38% (arrows).
False penumbra due to chronic upstream vessel stenosis. (a) The right cervical internal carotid artery (arrow) is narrowed throughout its course without focal occlusion. Note the normal caliber of the left internal carotid artery (arrow). (b) The stenosis increases $T_{\text{max}}$ resulting in the appearance of watershed distribution penumbra (arrows).

Overestimation of penumbra from skull base artifact. In addition to left MCA distribution ischemia, there is also apparent ischemia present just superior to the orbit within the right frontal lobe (arrow).
Overestimation of penumbra from encephalomalacia. (a) Encephalomalacia is seen in the bilateral occipital lobes (arrows). (b) The areas of encephalomalacia are included in penumbral territory (arrows) as defined by $\text{Tmax} > 6.0 \text{s}$.

**Conclusion:** Knowledge of sources of misclassification errors may aid in the prompt and accurate interpretation of CT Perfusion.

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References: