Automated CT Perfusion in Acute Ischemic Stroke: Pearls and Pitfalls

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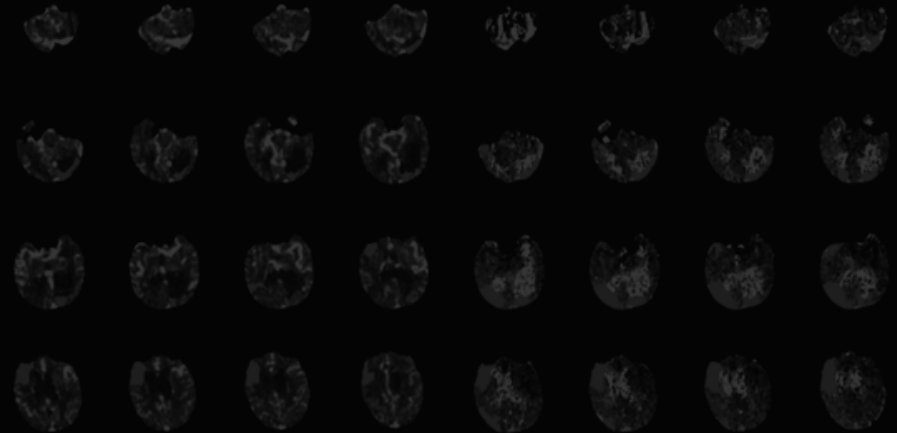Carl Flink, MD
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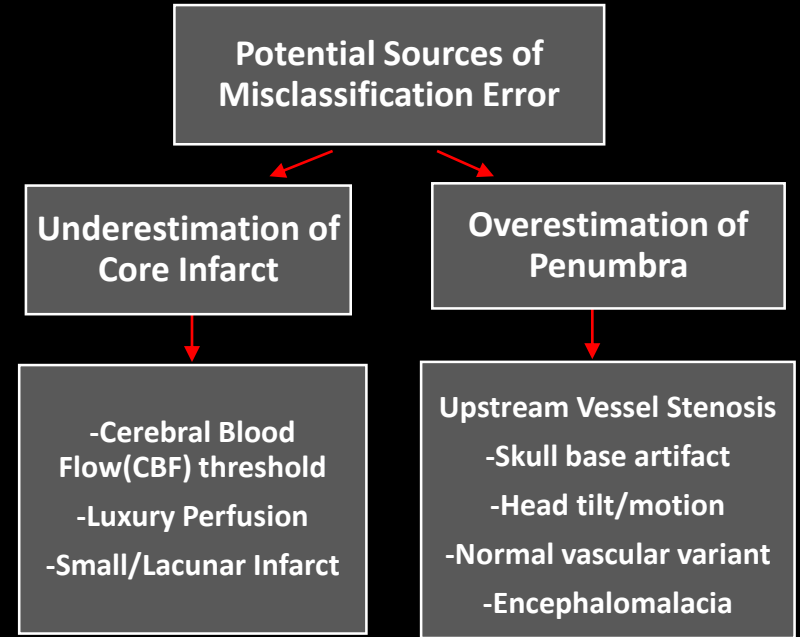University of Cincinnati Medical Center

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

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CTP Parameters

Parameter	Measures	Unit
Cerebral Blood volume(CBV)	Volume of blood within a voxel	ml/100g
Cerebral Blood Flow (CBF)	Volume of blood traversing a voxel per unit time	ml/100g/min
Mean Transit Time (MTT)	Average transit time of contrast bolus through a given volume of brain	seconds
Time to maximum (Tmax)	Time from arterial peak to tissue peak after deconvolution	seconds

$$CBF = CBV/MTT$$

Potential Sources of Misclassification Error

Underestimation of Core Infarct

Overestimation of Penumbra

-Cerebral Blood Flow(CBF) threshold
-Luxury Perfusion
-Small/Lacunar Infarct

Upstream Vessel Stenosis
-Skull base artifact
-Head tilt/motion
-Normal vascular variant
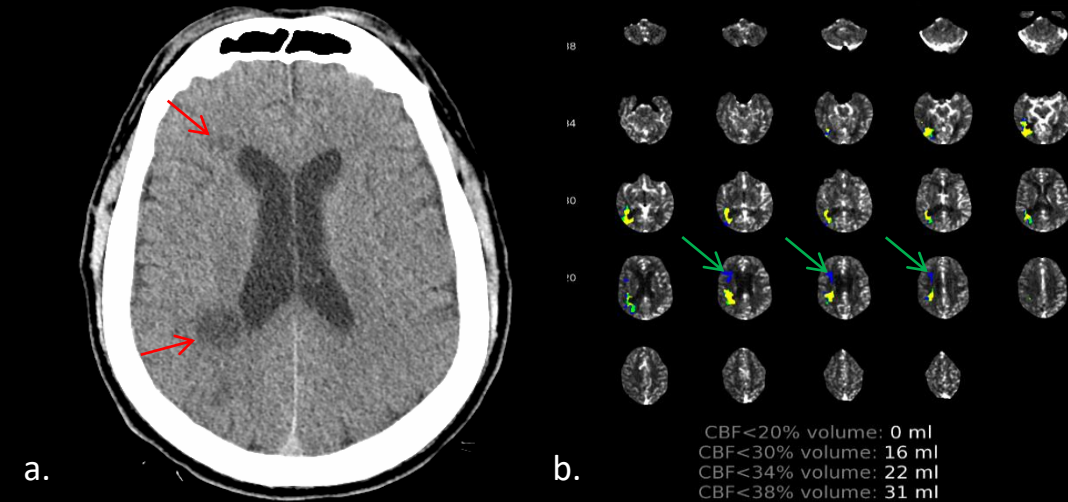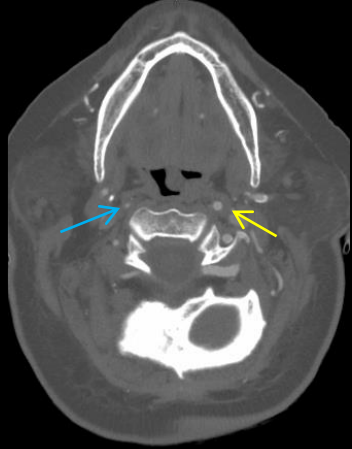-Encephalomalacia

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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.
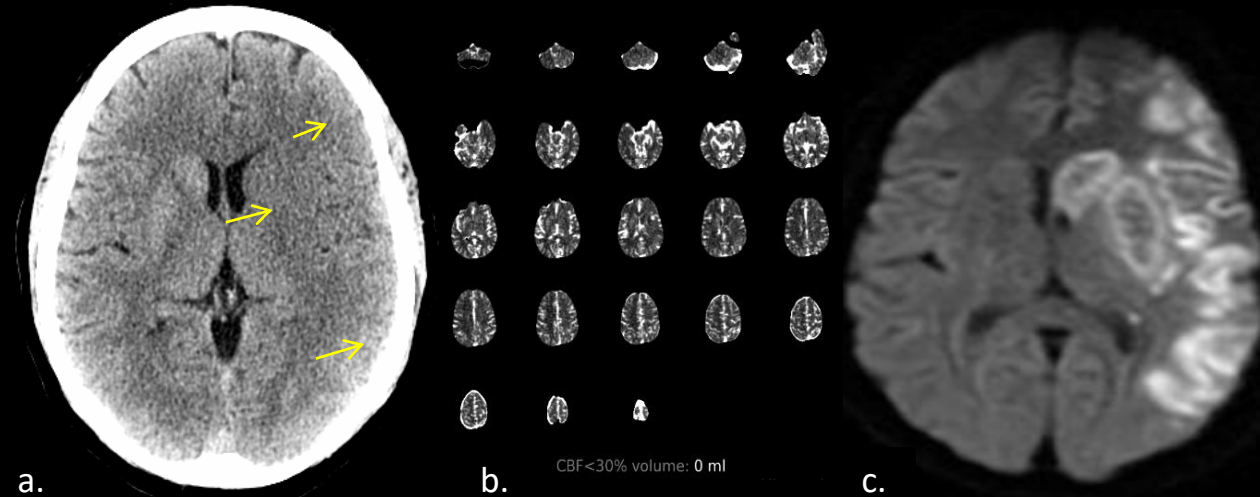
(a) In a different patient, areas of hypoattenuation are seen (arrows) representing areas of lacunar infarction. **(b)** The infarction adjacent to the anterior horn is not seen using a threshold of CBF <30%, only detected using a threshold of CBF <38%(arrows).

CBF<30% volume: 0 ml

CBF<20% volume: 0 ml
CBF<30% volume: 16 ml
CBF<34% volume: 22 ml
CBF<38% volume: 31 ml

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 Tmax resulting in the appearance of watershed distribution penumbra (arrows).
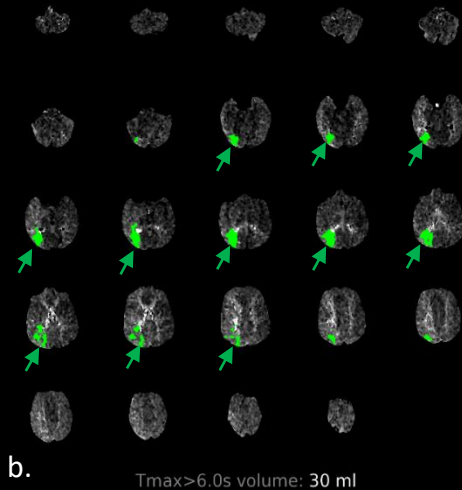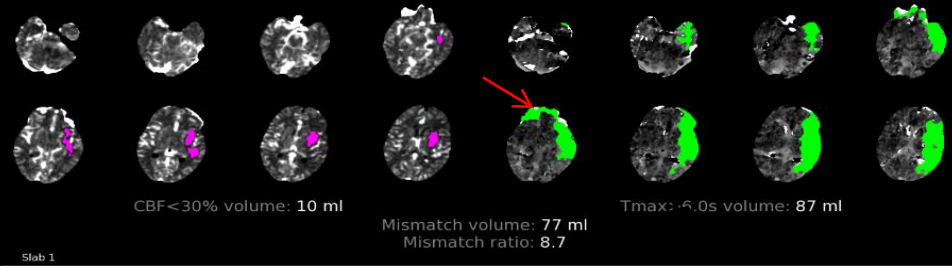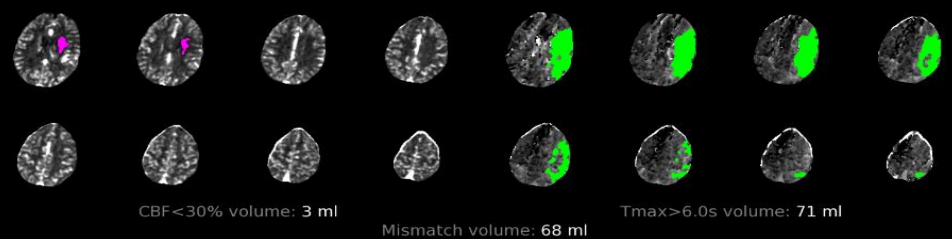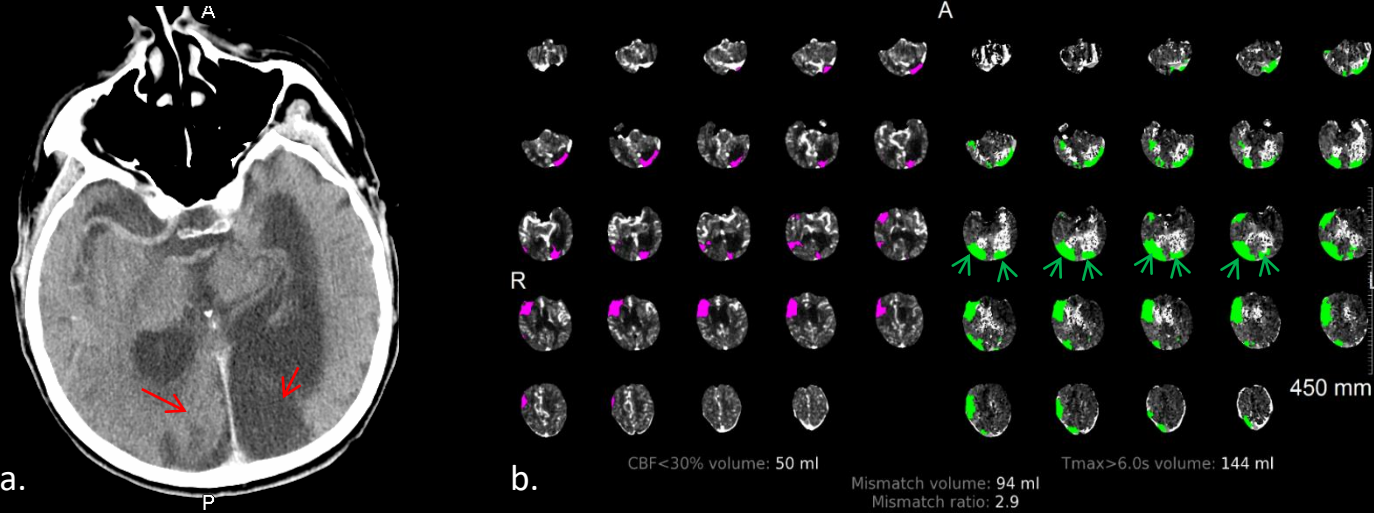
Overestimation of penumbra from skull base artifact. In addition to left MCA distribution ischemia, there is also apparent ischemia present just superior to the orbit within the right frontal lobe (arrow).

a.

b.

Tmax>6.0s volume: 30 ml

CBF<30% volume: 10 ml

Mismatch volume: 77 ml
Mismatch ratio: 8.7

Tmax>6.0s volume: 87 ml

Slab 1

CBF<30% volume: 3 ml

Mismatch volume: 68 ml
Mismatch ratio: 23.7

Tmax>6.0s volume: 71 ml

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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 Tmax >6.0 s.

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

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