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# CT Angiography Source Images with Modern Multisection CT Scanners: Delay Time from Contrast Injection to Imaging Determines Correlation with Infarct Core

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## CT Angiography Source Images with Modern Multisection CT Scanners: Delay Time from Contrast Injection to Imaging Determines Correlation with Infarct Core

We have read with great interest the letter by Dr Kloska[1] and a subsequent reply[2] concerning a study by Sharma et al,[3] investigating the perfusion imaging correlate of CTA source image (CTA-SI) lesions and would like to share our own data on this subject. On the basis of our findings, we agree with Dr Kloska that evaluation of acute ischemia with CTA-SI on state-of-the-art multisection CT scanners depends primarily on the imaging protocol.

In a recent investigation at our institution,[4] we analyzed 100 patients with acute ischemic stroke who underwent CTA-SI by using 2 different acquisition protocols with close follow-up DWI. We correlated CTA-SI hypoattenuation volumes with concurrent DWI hyperintense volumes and found that with the older protocol designed for a 4- or 16-section CT scanner (Table), CTA-SI volume correlated well with DWI volume. When a 64-section scanner was installed at our medical center, we modified our CTA acquisition protocol to improve arterial phase opacification (Table), and this was associated with significant overestimation of concurrent DWI volumes. Analysis of the CTA protocol parameters revealed that a shorter time from contrast injection to imaging of the ischemic territory was the single best predictor of CTA-SI overestimation of the infarct core on DWI. Imaging too soon likely prevented the contrast from traversing the collaterals and reaching the infarct bed. Most interesting, atrial fibrillation was associated with CTA-SI overestimation with the older protocol, which used a fixed delay, presumably related to delayed contrast-arrival time from reduced cardiac output.

Given these data, we conclude that CTA-SI, just like CT perfusion, requires protocol validation before being used to assess acute infarct size in clinical practice. Moreover, protocol parameters should be standardized. The Table illustrates the variable parameters that have been used in studies evaluating CTA-SI for acute ischemic stroke. Until these issues are fully addressed, CTA-SI should be used cautiously to inform treatment decisions in patients with acute ischemic stroke.

### References


1. Kloska SP. **CT angiographic source images with modern multisection CT scanners: appropriate injection protocol is crucial.** *AJNR Am J Neuroradiol* 2011;32:E93
2. Aviv RI, Sharma M, Lee TJ. **Reply.** *AJNR Am J Neuroradiol* 2011;32:E94
3. Sharma M, Fox AJ, Symons S, et al. **CT angiographic source images: flow- or volume-weighted?** *AJNR Am J Neuroradiol* 2011;32:359–64
4. Pulli B, Schaefer PW, Hakimelahi R, et al. **Acute ischemic stroke: infarct core estimation on CT angiography source images depends on CT angiography protocol.** *Radiology* 2012;262:593–604
5. Schramm P, Schellinger PD, Fiebach JB, et al. **Comparison of CT and CT angiography source images with diffusion-weighted imaging in patients with acute stroke within 6 hours after onset.** *Stroke* 2002;33:2426–32
6. Schramm P, Schellinger PD, Klotz E, et al. **Comparison of perfusion computed tomography and computed tomography angiography source images with perfusion-weighted imaging and diffusion-weighted imaging in patients with acute stroke of less than 6 hours' duration.** *Stroke* 2004;35:1652–58
7. Wittkamp G, Buerke B, Dziewas R, et al. **Whole brain perfused blood volume CT: visualization of infarcted tissue compared to quantitative perfusion CT.** *Acad Radiol* 2010;17:427–32



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**Overview of CTA protocols used in previous CTA-SI studies of acute stroke**

| Study | Sharma et al, *AJNR* 2011[3] | Pulli et al, *Radiology* 2011[4] | Pulli et al, *Radiology* 2011[4] | Schramm et al, *Stroke* 2002[5] | Schramm et al, *Stroke* 2004[6] | Wittkamp et al, *Acad Radiol* 2010[7] |
|---|---|---|---|---|---|---|
| CT scanner | 64-section | 64-section | 4- or 16-section | Single-section | 4-section | 64-section |
| Acquisition direction | Caudocranial | Craniocaudal | Caudocranial | Caudocranial | Caudocranial | N/A |
| Table speed | 3.7 mm/s | 9.38–39.38 mm/s | 3.75–5.68 mm/s | N/A[a] | N/A[a] | 61.35 mm/s |
| Contrast injection | ≤90 mL at 5 mL/s | 65–100 mL at 3–4 mL/s | 95–140 at 3–3.5 mL/s | 130 mL at 5 mL/s | 40 mL at 5 mL/s, 25 mL at 2.5 mL/s | 80 mL at 4 mL/s |
| Saline flush | 40 mL at 5 mL/s | 40 mL at 4 mL/s | None | None | None | 50 mL at 4 mL/s |
| Injection duration | ≤18 s | 16–32 s | 40–60 s | 26 s | 18 s | 20 s |
| Delay time | 5–10 s | SmartPrep,[b] aortic arch (average, 22 s) | 25 s | 17 s | 17 s | Peak enhancement at superior sagittal sinus |
| Timing of CT perfusion relative to CTA | After | After (if performed) | After (if performed) | N/A | Before | Before |
| CTA-SI correlate | CTP-CBF | >MR-DWI | MR-DWI | MR-DWI | MR-DWI | CTP-CBV |
| Agreement with infarct core | Poor, overestimation | Poor, overestimation | Good | Good | Good | Good |

**Note:**—N/A indicates not applicable.
[a] Although the investigators did not state the table speed in their work, it can be presumed to be relatively slow because scanners of this generation were not capable of acquiring at higher speeds.
[b] GE Healthcare, Milwaukee, Wisconsin.