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## CT Angiography Source Images with Modern Multisection CT Scanners: Attention to Technical Principles Is Crucial

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With interest I read the recently published article by Choi et al. [1]. The study correlated the Alberta Stroke Program Early CT Score (ASPECTS) on nonenhanced CT, conventional contrast CT (CECT) and CT angiography source images (CTA-SI) performed by modern multisection CT scanners with the pial collateral flow based on four-vessel angiography in patients with acute ischemic stroke. The authors reported that 'CECT showed more correlation with pial collateral circulation than CTA-SI' and concluded that 'ASPECTS on CECT has potential for being a stronger predictive marker of cerebral blood volume and a possible prognostic factor in acute ischemic stroke patients'. This observation is in contrast to previous reports of the blood volume basis for CTA-SI [2]. In my opinion, the reported results for CTA-SI in the article by Choi et al. [1] need further discussion, and detailed consideration of the underlying principle of CTA-SI is required.

CTA-SI, like the related techniques of perfusion-weighted CT and perfused blood volume images, are based on the principle that was first reported by Hamberg et al. [3]. With the assumption of vascular and tissue contrast steady state in CTA data, the calculation of cerebral blood volume (CBV) can be reduced to the equation

$$CBV = \frac{\max c(t)}{\max v(t)} \qquad \left[\mathrm{ml} \cdot 100\ g^{-1}\right],$$

where max c(t) is the maximum tissue concentration and max v(t) is the maximum vascular concentration of the marker. This eliminates the need for dynamic CT data acquisition and results in qualitative information on CBV in CTA-SI. Hence, the performance of CTA data acquisition at the plateau phase of contrast injection, with vascular and tissue contrast steady, is a prerequisite. With former generations of CT scanners, dedicated injection protocols in CTA were not that crucial as the slow scan time 'automatically' resulted in an appropriate bolus configuration to fulfill the algorithm of CTA-SI [2]. In contrast, the fast scan time of modern CT scanners requires very accurate bolus timing for CTA. Choi et al. [1] used a bolus tracking method and commenced the scan when enhancement in the carotid arteries reached 120 Hounsfield units, used 100 ml of 68% nonionic contrast agent and a flow rate of 4 ml/s without saline flush. CECT was started about 80 s after contrast injection. Considering the fast scan time of the 16-section CT scanner used, this injection protocol results in distinct arterial contrast for CTA data. However, the mandatory assumption for CTA-SI according to the considerations by Hamberg et al. [3] is thereby violated. Hence, the size of CTA-SI lesions is overestimated. It is not surprising that Choi et al. [1] found a better correlation between CECT and dichotomized pial collateral flow compared with CTA-SI. In consequence, the results of Choi et al. [1] do not contradict the blood volume basis of CTA-SI, but point out the importance of appropriate injection protocols in conjunction with modern multisection CT scanners to fulfill the requirements for appropriate use of CTA-SI. Further comparative studies are needed to evaluate CTA-SI with appropriate injection protocols on modern multisection CT scanners for the approximation of pial collateral flow derived from four-vessel angiography.

*References*

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