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Goliath and the ant: whole-brain CT perfusion against 16-slice CT angiography in stroke imaging



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Dear Editor,

We read with interest the recent paper by Becks et al. [1], reporting how whole-brain computed tomography (CT) perfusion (WB-CTP) improved the detection of distal vessel occlusions over data from CT angiography (CTA). Interestingly, the identification of an area of altered brain perfusion on CTP maps, especially in the mean transit time or time to peak (MMT and TTP), prompts the observer to pay close attention to the CTA information on vascular structures in this area so as to detect the occlusion.

We should like to make some considerations as to this.

Recognising intracranial occlusions on CTA can be challenging, especially in the distal intracranial branches. The multiphase CT Angiography (m-CTA), a novel and user friendly-imaging technique, aims at evaluating the degree and extent of collaterals, thus providing information on whether to proceed (or not) with endovascular therapy. Furthermore, recent data have shown that m-CTA also improves diagnostic accuracy in the detection of distal vascular occlusion over single CTA (s-CTA) [2,3].

Indeed, all is needed is that a high-speed multidetector CT (MDCT) scanner, with ≥ 64 slices acquisitions, obtains data in the late arterial, mid-venous and late venous phases [2]. However, in a real world scenario, most Community Hospitals are not privileged with such a high technology (m-CTA and/or WB-CTP) and have to make do with lower speed MDCT scanners (< 64 detectors).

The idea of being able to carry out a perfusional study of the whole brain is endearing, but this implies the availability of a CT scanner of the latest generation with 320 detectors. Consequently, improvement in the speed and confidence of image interpretation on CTA for the detection of distal vessel occlusion with lower speed scanners would be of great help in routine practice: this is especially true in light of the new indications for thrombectomy treatment of M2 and M3 segment occlusion (class recommendation, IIb) [4]. Our experience performing dual-phase CTA (d-CTA) on a 16 slice MDCT with a biphasic rate injection [5] (Fig. 1A–B) is presented herein.

A total of 33 consecutive patients with distal middle cerebral artery (MCA) occlusions (M2 or M3 segments), admitted to our institution for acute ischemic stroke between January 2016 and June 2017 were evaluated by the d-CTA technique. The goal was to determine whether using d-CTA data, obtained on a 16 slice MDCT scanner, could improve inter-rater agreement for the detection of distal MCA occlusion compared to single-phase CTA (s-CTA). An expert stroke neuroradiologist and 2 general radiologists evaluated data from s-CTA and d-CTA, to assess the presence of a distal MCA occlusion. The first phase of the d-CTA was acquired in the late arterial phase and was defined as the s-CTA. When reviewing the s-CTA data, the readers had access only to the first arterial phase. When reading the d-CTA data, they had access to both imaging phases. All the readers independently assessed all 33 studies randomly and were blinded to clinical data. Follow-up CT or MRI were reviewed by the same neuroradiologist who documented the presence and location of acute infarcts which served as the reference standard for occlusion detection. There was a fair s-CTA inter-rater agreement ($k=0.39$) among the readers and a substantial agreement ($k=0.76$) for distal occlusion detection, when the d-CTA was used.

As the “delayed vessel sign” refers to vessel opacification on delayed phase images distal to a point of arterial occlusion, the identification of delayed vessel enhancement may significantly enhance image interpretation [6].

The neuroradiologist observed the delayed vessel sign (Fig. 1D and E) in 9/33 cases and the general radiologists in 8/33 cases, with almost perfect agreement ($k=0.89$). The total estimated effective radiation dose for our protocol is 5.3 mSv (unenhanced head CT, 2.5 mSv; two phases circle of Willis CTA, 1.2 mSv; neck CTA, 1.6 mSv), which is inferior to multiphase stroke protocol on a 64 slice MDCT reported by Menon et al. (8.5 mSv) [2].

Our data showed that the inter-rater agreement for the detection of distal MCA occlusions between the general radiologists and the expert neuroradiologist was high when d-CTA was used and even more so for the detection of the delayed vessel sign. Conversely, inter-reader agreement was only fair with standard s-CTA.

We are aware that this study does have some limitations, i.e. the small sample size and the fact that there was no comparison with angiographic imaging.

Although these preliminary results require further confirmatory studies, the authors are of the opinion that the proposed protocol, adapted to a low speed MDCT scanner, may well prove to be a cost/effective tool for those hospitals still awaiting more modern technology

Ethical approval

Human and animal studies were approved by the local ethics committee and were, therefore, performed in accordance with the

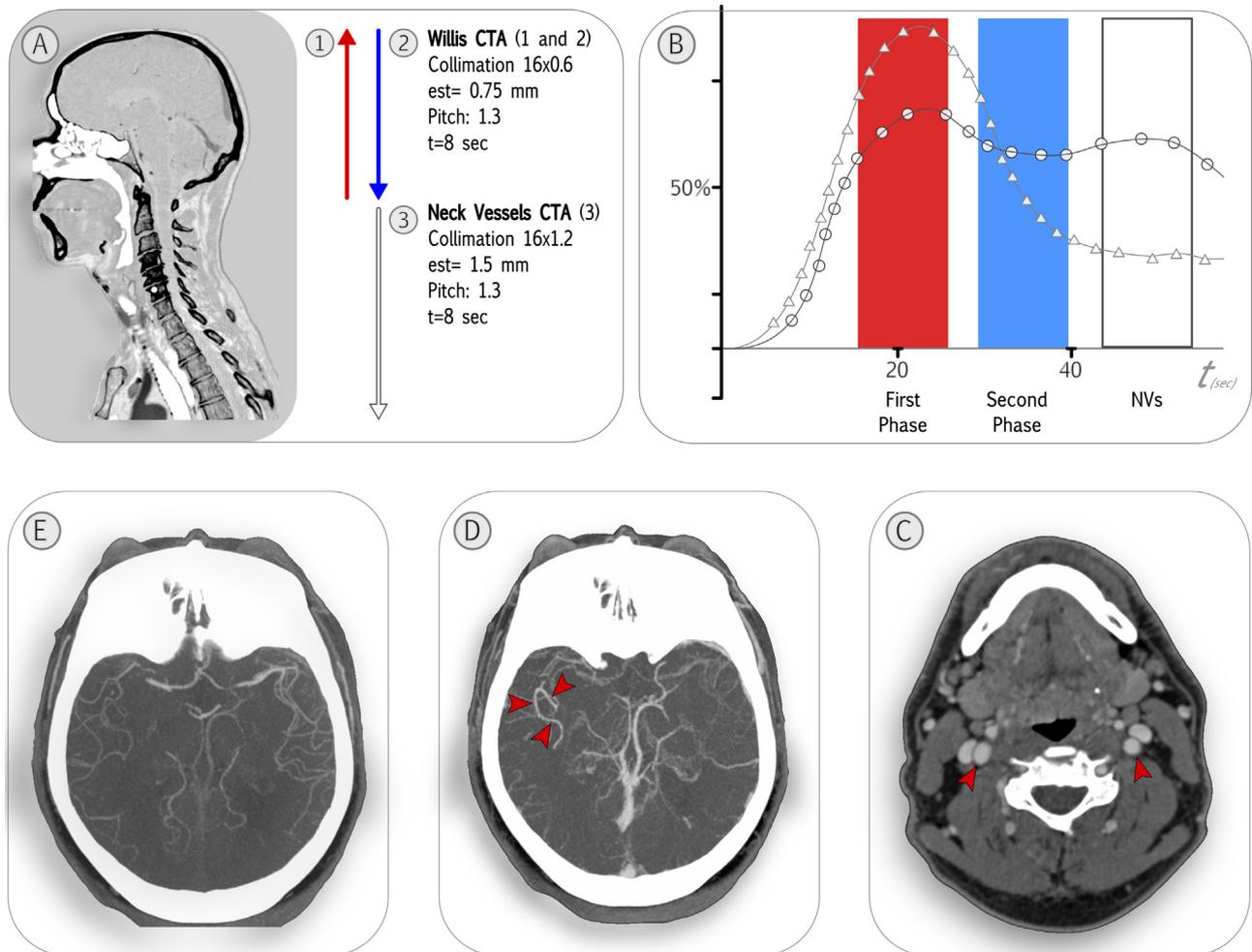


Fig. 1. CT angiograms of the intracranial vasculature were obtained by a 16 slice MDCT scanner in two phases after contrast medium injection. For the late arterial phase, obtained from skull base to vertex, bolus tracking was utilized to monitor the arrival of contrast into the pre-petrous internal carotid artery segments. The second imaging data were acquired during the late venous phase, from the vertex to the skull base. Each scan phase lasted 8 seconds, with a 4 second interval. An additional scan was performed afterwards on the neck vessels, from the skull base to the aortic arch, with a different detector configuration to shorten the acquisition time. So as to maximize spatial resolution in the intracranial vessels and increase the acquisition rate in the neck, a dual detector configuration must be used. CTA scan parameters: 110 kV, 100 eff. mAs, a 0.6 second rotation time, a 1.3 pitch, a 16×0.6 mm collimation, an effective slice thickness of 0.75 mm for the circle of Willis CTA and 110 kV, 100 eff. mAs, rotation time of 0.6 seconds, a 1.3 pitch and a collimation of 16×1.2 mm, an effective slice thickness of 1.5 mm for the neck vessel CTA. A. d-CTA images with slow-speed 16 slice MDCT scanner, each phase is represented by an arrow. B. The curve with the circle points illustrates the configuration of the geometry bolus with a biphasic rate injection (50 cc at a rate of 4.5 mL/s, subsequently 30 cc at 2.5 mL/s, followed by a 50-mL normal saline chase at a rate of 2.5 mL/s; for comparison bolus single rate injection is shown on the curve with a triangle). Adequate persistent opacification of the carotid arteries is shown in C (arrows). D. Axial MIP of d-CTA in the late venous phase (second phase), demonstrating the presence of the “delayed vessel sign” (arrows) in the vascular territory of the right distal MCA. The late arterial phase (first phase) is shown in E. est: effective slice thickness; t: scan time; NVs: neck vessels.

ethical standards as stipulated in the 1964 Declaration of Helsinki and its later amendments.

The patients enrolled into the study gave written informed consent.

All the data on research materials related to this paper, e.g. data, samples and/or models, can be accessed.

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Disclosure of interest

The authors declare that they have no competing interest.

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