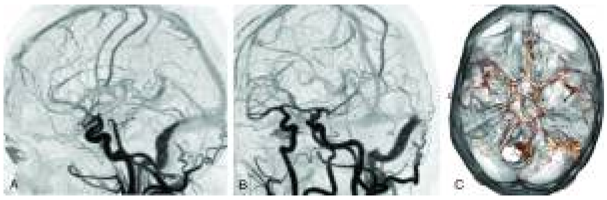
Four dimensional computed tomography angiography



Intracranial vascular malformations can be detected with 4D-CTA and clinically evaluated using information related to vascular fluid dynamics. The use of 4D-CTA provides data related to ongoing vascular changes as well as accurate spatial delineation of cerebrovascular pathologies. Overall, 4D-CTA is increasing its role in neuroimaging by providing superior information regarding structural three-dimensional imaging quality and real-time flow [1).

Mizutani et al. retrospectively analyzed 97 veins from 26 patients (16 cases of arteriovenous shunt disease, nine intracranial tumor cases, and one cerebral aneurysm case) who underwent both 4D-CTA and conventional digital subtraction angiography (DSA). Using 4D-CTA, they analyzed the time-density curve with gamma distribution extrapolation and obtained the direction of the flow and flow velocity of each vein. The direction of the flow in 4D-CTA was also collated with that obtained using conventional DSA to verify the experimental method.

The direction of the flow determined by 4D-CTA was consistent with that of conventional DSA in 94.8% of cases. The average venous flow velocity was 64.3 mm/s and 81.8 mm/s, respectively, in the antegrade and retrograde channels affected by arteriovenous shunts.

The current flow analysis using 4D-CTA enabled to evaluate the direction and velocity of intracranial venous flow. Aside from some limitations, the current method is reliable and its potential for application in clinical settings is promising [2)].

A total of 44 patients with cerebral aneurysm, treated using clipping surgery, were included in this study. The metal artifact volume was assessed using CTA and the association between the type of clips and its metal artifact volume was analyzed. A VR image and a 4D-CTA were then produced, and the diagnostic accuracy of arteries around the clip or residual aneurysm on these images was evaluated. In the receiver operating characteristic (ROC) curve analysis, the cutoff value for metal artifacts was 2.32 mm3 as determined through a VR image. Patients were divided into two groups. Group 1 included patients with a simple and small clip, and group 2 included patients with multiple, large or fenestrated clips. The metal artifact volume was significantly larger in group 2, and the group incorporated the cutoff value. Post-clipping status on the VR image was significantly superior in group 1 compared with group 2. In group 2, the imaging quality of post-clipping status on 4D-CTA was superior in 92.9% of patients. The metal artifact volume was dependent on the number, size, or configuration of the clip used. In group 2, evaluation using a 4D-CTA eliminated the effect of the metal artifacts [3)].

Two patients with intracerebral hemorrhage both showed an assumed spot sign on CTA, suggesting active hemorrhage. Additional 4D-CTA showed true active hemorrhage in one patient and a distal intracranial aneurysm in the other. This aneurysm was initially falsely interpreted as a spot sign on conventional CTA.

This case findings show how 4D-CTA can discern active bleeding from aneurysmal hemorrhage in cases with hemorrhagic stroke. This finding proves the additional value of this relatively new technique, because the detected underlying disorders have different therapeutic consequences in the acute setting [4].

In the diagnostic process of spinal VMs, the position of 4D-CTA is the third choice for noninvasive angiography, after dynamic MRA and three-dimensional CTA. However, the role of 4D-CTA might be decisive in difficult-to-find spinal dural AVFs. We believe that this novel imaging technique can be applied in spinal VMs [5].

Alnemari et al. presented 6 cases that best elucidate the application and technical nuances of 4D-CTA and its advantages over traditional digital subtraction angiography.

Intracranial vascular lesions can be detected with 4D-CTA and clinically evaluated using information related to vascular flow dynamics. The use of 4D-CTA provides data related to ongoing vascular changes as well as accurate spatial delineation of cerebrovascular pathologies. Overall, 4D-CTA is increasing its role in neuroimaging by providing superior information regarding structural three-dimensional imaging quality and real-time flow [6].

Ye et al. reported 16 patients who were diagnosed to have intracranial DAVF by digital subtraction angiography (DSA). The 4D-CTA was performed by Aquilion ONE multi-detector CT scanner (Toshiba Medical Systems, Japan) equipped with 320 × 0.5 mm detector rows. Standard biplane fluoroscopy equipments (Infinix, Toshiba Medical Systems, Japan and ADVANTX LC/LP, GE Medical Systems, Milwaukee, WI, USA) were applied in the diagnosis of intra-arterial DSA. Examinations were performed to evaluate the findings of DSA and 4D-CTA in each patient. The examination results were read by two independent readers in a blind manner. All results were documented on standardized scoring sheets. In all 16 cases, the same diagnosis results of intracranial DAVF were obtained from DSA and 4D-CTA. The results of subtype (Borden and Cognard classification), venous reflux and fistula sites were also accurately exhibited in 4D-CTA. In addition, there was a little discrepancy in identifying smaller and specific arterial branches and in distinguishing fistula type (focal or diffuse) using 4D-CTA. Good-to-excellent agreements were made between 4D-CTA and DSA. Therefore, 4D-CTA could be a feasible tool for the characterization of intracranial DAVF, with respect to determining fistula site and venous drainage [7].

A retrospective review was made to assess the accuracy of 4D-CTA) in diagnosis of arteriovenous malformations (AVM) and dural arteriovenous fistulas (DAVF), with catheter-based digital-subtraction angiogram (DSA) being gold standard. 33 pairs of investigations (DSA and 4D-CTA) were performed primarily for suspicion of AVM/DAVF. Based on blinded reports, sensitivity and specificity for detection of AVM/DAVF were 77% (95% CI: 46-95%) and 100% (95% CI: 83-100%) respectively. Positive predictive value was 100% (95% CI: 69-100%) and negative predictive value 87% (95% CI: 66-97%). 4D-CTA is a practical minimally-invasive technique for evaluating cerebrovascular pathologies. There is good agreement between the findings of 4D-CTA and DSA despite the differences in temporal and spatial resolutions. 4D-CTA may obviate the need for DSA in a subgroup of patients who would otherwise have undergone this invasive investigation, which carries a risk of important complications [8].

References

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