

## High-resolution cone beam CT for evaluation of vascular channel in intracranial partial thrombosed aneurysm

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### ABSTRACT

The authors present a 60-year-old man with a partially thrombosed, intracranial vertebral artery aneurysm. A vascular channel in intra-aneurysmal thrombus was effectively identified with high-resolution cone beam CT (DynaCT Micro: Siemens Medical Solutions, Erlangen, Germany). Pre-procedural vertebral angiogram implied a perforating artery arising from near neck of the aneurysm and DynaCT Micro performed before approaching to the lesion demonstrated a vascular channel running in intra-aneurysmal thrombus which could not be distinguished from perforators with other imaging modalities. It was confirmed that perforators around the aneurysm were not identified and safely treated the aneurysm with stent-assisted coil embolization. High-resolution cone beam CT is enable to sharply visualize vessel lumens, thrombus, and intra-thrombus structures, and is useful to identify a vascular channel in intracranial partially thrombosed aneurysm.

Keywords: cone beam CT, angiogram, intracranial aneurysm, thrombosed aneurysm, vascular channel

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### INTRODUCTION

Many arterial vessels including perforators to brain stem, as well as posterior inferior cerebellar artery (PICA) and anterior spinal artery, are branched from vertebral artery (VA). It is important to preserve those small vessels in the treatment of VA aneurysms for avoiding critical complications as perforator infarction.<sup>1)</sup> Imaging modalities, such as high-resolution multidetector CT, high field MRI and cone beam CT have developed and applied to visualize fine anatomical structures and perforating arteries. However, limitations of resolution and imaging provision were still remained.<sup>2-5)</sup>

DynaCT Micro (Siemens Medical Solutions, Erlangen, Germany) is a novel imaging modality which uses a flat plane detector to generate CT-like images using the same C-arm employed for digital subtraction angiogram, and provides more spatial resolution than conventional DynaCT.

Received: October 30, 2017; accepted: November 16, 2017

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This modality enables to visualize more clearly deployed stent with low-consolidation contrast medium and fine structures like small vessels.

In this article, we present a case with a partially thrombosed, intracranial VA aneurysm that a vascular channel in intra-aneurysmal thrombus was effectively identified with high-resolution cone beam CT (DynaCT micro).

#### *DynaCT Micro*

Angiograms and DynaCT Micro were performed on a biplane angiography system equipped with flat panel detectors (Artis Q BA Twin, Siemens AG, Forchheim, Germany) and a parallel established workplace (syngo X-Workplace VC10C, Siemens AG). The acquisition of rotational datasets was performed with the following parameters: 20sDCT Micro; X-ray tube voltage: 109[kV], tube current: 460[mA], 200° total angle, 496 frames, 20[s] rotation, 22[cm] zoom size (detector size: 30×40[cm]). Post-processing of the image data to a volume dataset and reconstruction of cone beam CT images was performed automatically on a syngo X-Workplace (DynaCT, InSpace 3D software, Siemens AG). The software includes the application of system-specific filter algorithms in order to correct for beam hardening, radiation scatter and truncated projections. Post-processing resulted in volume datasets each defined by a batch of approximately 400 slices in a 512×512 matrix. Voxel size was approximately 0.15×0.15×0.15[mm<sup>3</sup>]. Multiplanar reconstruction (MPR) slices and maximum intensity projection (MIP) technique that the volume datasets were further processed to allow to parallel and perpendicular to the concern area, respectively. DynaCT Micro scanning was started after scan delay time under injection of contrast medium. The contrast medium used for DynaCT Micro in our institution was Iopamiron 300[mgI/ml] (Bayer Yakuhin, Osaka, Japan) diluted to about 14% with saline to reduce agent concentration.

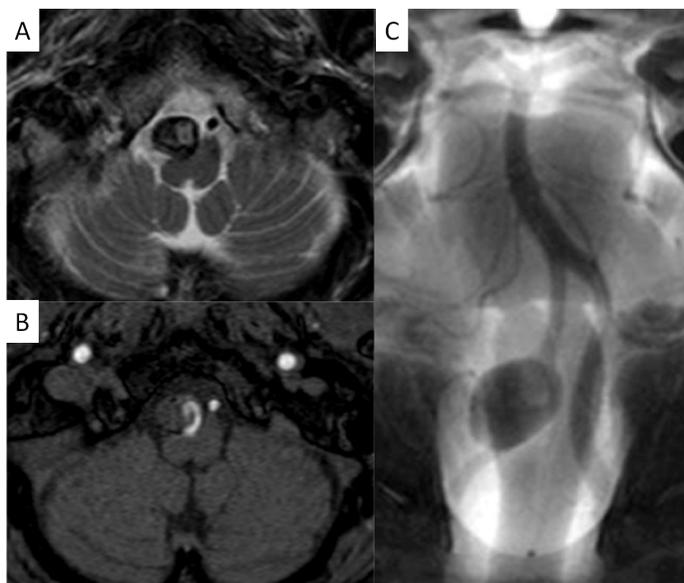
## CASE PRESENTATION

A 60-year-old man was diagnosed with an unruptured, right VA aneurysm on MR imaging including MR angiogram during work-up for occipital headache. At that time he had no neurological deficit, however, he was suffered from mild ataxia because of right cerebellar infarction derived from intra-aneurysmal thrombus in a few months.

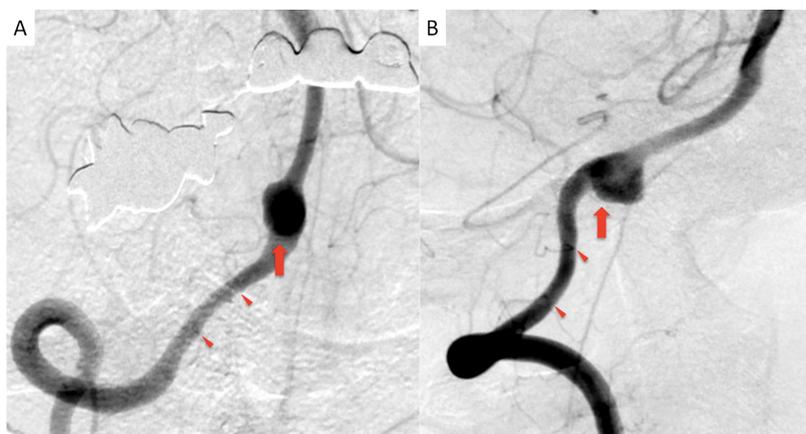
MR imaging and enhanced CT showed approximately 12[mm] aneurysm in right VA with intra-aneurysmal thrombus (Fig.1). Pre-procedural VA angiogram showed a 6.6×6.6×3.6[mm] aneurysm, apparent perforators arising from the proximal VA to medulla, and it illustrated a tiny lumen, implied another perforating artery arising from near proximal neck of aneurysm (Fig.2). DynaCT Micro was performed to evaluate the lumen. MPR images of DynaCT Micro demonstrated a vascular channel running in intra-aneurysmal thrombus (Fig. 3) which could not be distinguished from perforators by other imaging modalities as conventional angiogram, multidetector CT and MRI. Therefore, it was confirmed that perforators were not branched around the aneurysm.

It seemed that occluding a parent artery was difficult within a short range, especially with endovascular technique, preserving perforators in the proximal VA. While the aneurysm was partially thrombosed and had wide neck, the relatively small size of this aneurysm would be enabled to achieve saccular packing. We planed the strategy from the above that coil embolization with stent assist was performed firstly and parent artery occlusion was considered at the time of recurrence.

Endovascular intervention was performed with stent-assisted technique. A 7Fr guiding catheter was placed at his right VA via a transbrachial approach. Then, the stent-deploying catheter



**Fig. 1** Axial views of MRI T2 weighted image (A) and time of flight (B) shows VA aneurysm with intra-aneurysmal thrombus. (C) MRI BPAS (basi-parallel anatomical scanning) showed the dilated outer membrane of the right VA, maximum diameter 12mm.

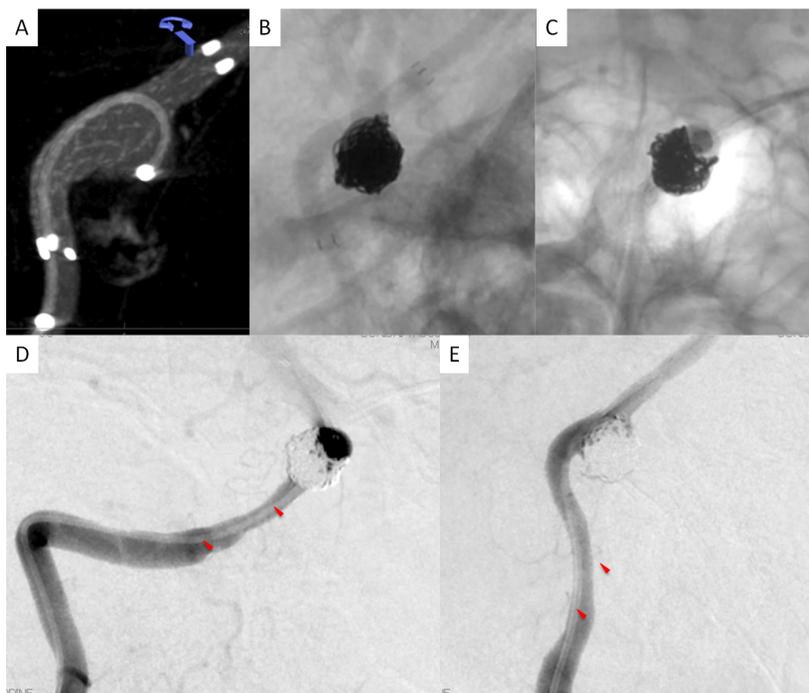


**Fig. 2** Preprocedural right vertebral angiography of working projection showing a 6.6×6.6×3.6mm aneurysm, perforators arising from the proximal VA to the medulla (arrow head), and illustrating a tiny lumen arising form the near proximal neck of the aneurysm (arrow) in (a) anteroposterior and (b) lateral views.

(Prowler Select Plus: Codman Neurovascular, Raynham, Massachusetts, USA) was advanced to the right VA and a microcatheter for coiling (SL-10: Stryker, Fremont, California, USA) was inserted into the aneurysm sac. Thereafter, the stent (Enterprise VRD 4.5mm–22mm: Codman Neurovascular) was deployed in the right VA. After stent deployment, the aneurysm was embolized from the jailed microcatheter with 5 hydrogel coils and 11 bare coils in total. Framing was constructed with HydroFrame (MicroVention Terumo, Tustin, California, USA) and filled with HydroSoft (MicroVention Terumo). Finishing was carried out with Target Ultra (Stryker)



**Fig. 3** DynaCT Micro demonstrating that the tiny lumen was a vascular channel (arrow) running in the intraneurysmal thrombus (dot line) and was not a perforator feeding the brain stem in (a) coronal and (b) sagittal views of MPR image.



**Fig. 4** (A) MIP image of conventional DynaCT showing deployed stent and induced microcatheter with jailing technique. Non-subtraction (B and C) and subtraction (D and E) right vertebral angiogram obtained after embolization. The patency of perforators arising the proximal VA was confirmed (arrow head).

and ED Coil Extrasoft (Kaneka Medics, Osaka, Japan).

Post-procedural VA angiogram showed embolized aneurysm with small neck remnant although the patency of perforators arising the proximal VA was confirmed (Fig. 4). Ischemic complications were not observed postoperatively.

## DISCUSSION

Vertebral artery aneurysms are treated with appropriate methods including clipping, coiling with/without stent assist, proximal occlusion, or internal or surgical trapping, depending on the clinical and anatomical feature.<sup>6,7)</sup> As previously described, it is important to preserve arterial branches in the treatment of VA aneurysms.

Intracranial partially thrombosed aneurysms are still difficult to manage both endovascularly, as well as surgically. Parent artery occlusion is the treatment option but it is often difficult to treat when branches are arising from parent artery. Recurrences and rebleedings of treated thrombosed aneurysms have been reported and supposed in association with vasa vasorum. Iihara, *et al.* described vascular channels pathologically as developed vasa vasorum passing in intra-aneurysmal thrombus.<sup>8)</sup> However, there were no reports to recognize vascular channels in an angiogram.

In our case, we regarded the tiny lumen as a perforator arising from the aneurysm neck at first, and were concerned with the risk of medullary infarction due to aneurysm embolization. However, high-resolution cone beam CT apparently visualized the lumen localizing in the intra-aneurysmal thrombus, and allowed to identify the vascular channel and to treat the aneurysm with stent-assisted coil embolization safely.

Regarding the radical treatment for VA dissecting, fusiform or thrombosed aneurysms, parent artery occlusion is superior to intra-aneurysmal coil embolization. However, ischemic complications of endovascular treatment in VA aneurysms were 7.5–9.6% in cases of internal coil trapping.<sup>9,10)</sup> Mahmood *et al.* described perforator arteries mainly arise from 14[mm] below to 16[mm] above the vertebrobasilar junction.<sup>11)</sup> Saeki *et al.* reported 3.2 small branches originated from the intracranial portion of the VA with PICA, while 3.8 branches from VA without PICA in fifty intracranial VA which were observed under operating microscope.<sup>12)</sup> In this case, we recognized perforators arising from the proximal parent artery of the aneurysm, and did not select parent artery occlusion to avoid medullary infarction. High-resolution cone beam CT in combination with conventional angiogram obtained by flat-plane detector enables to evaluate thinner perforators.

Conventional cone beam CT such as DynaCT which visualizes high-contrast structures, like bone, calcified lesions, and metallic materials, as well as multidetector CT does, improved intra-procedural deployed stent visualization,<sup>13)</sup> and demonstrated small perforating arteries originating through the stent struts.<sup>14)</sup> While, conventional DynaCT was inferior to multidetector CT in a point of visualization of contrast differentiation of soft tissue such as cerebral cortex, muscle, and hematoma.<sup>15)</sup>

DynaCT Micro provided high-resolution imaging sharply visualized vascular lumen, intra-aneurysmal thrombus and tiny vascular channel in the thrombus. Additionally, DynaCT micro demonstrated vasa vasorum running in intra-aneurysmal thrombus which could not be visualized with other imaging modalities. This case is one of the first report to demonstrate a vascular channel in thrombus with angiogram and cone beam CT, to the extent that we collected.

## CONCLUSIONS

High-resolution cone beam CT is able to sharply visualize vessel lumens, thrombus, and intra-thrombus structures, and is useful to identify a vascular channel in intracranial partially thrombosed aneurysm.

## COMPETING INTERESTS

The authors have no personal, financial interest in any of the materials or devices described in this article. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## ACKNOWLEDGEMENTS

The authors would like to thank Keisuke Ota, MD (Anjo Kosei Hospital), Hayato Tajima, MD (Handa City Hospital), Tasuku Imai, MD (Ogaki Municipal Hospital), Masashi Ito, MD (Kasugai Municipal Hospital) and Masahiro Nishihori, MD (Nagoya University), for their generous support in this study.

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