Use of Dyna-CT Angiography in Neuroendovascular Decision-Making

A Case Report

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Summary

A successful neuroendovascular procedure depends on accurate anatomical understanding of a target vessel in relation to surrounding anatomical structures or endovascular devices, such as coils and stents. During an endovascular procedure, with conventional or three dimensional (3D) rotational angiography, this type of information is extremely difficult to obtain in a timely manner. To overcome this drawback, a DynaCT was combined with low dose contrast injection to create CT angiography (CTA)-like images (DynaCTA). The images obtained were similar to those of conventional CTA but with better quality in analyzing vessels to surrounding anatomical structures and endovascular devices while the patient was on the table. The authors present three illustrative cases in which information added by the DynaCTA helped improve understanding of anatomy, and affected our clinical decision-making. Although better quality images may be obtained by other imaging modalities or careful angiographic interpretations, DynaCTA can be an easy and effective rescue technique worth keeping in mind in clarifying the relation of a vessel to surrounding anatomy.

Introduction

For successful neuroendovascular procedures, it is important to understand vessel

anatomy in relation to bony landmarks, brain structures or endovascular devices such as coils and stents. However, digital subtraction angiography (DSA) or three dimensional (3D) rotational DSA may not be optimal in this aspect. DynaCT is a new technology that uses a C-arm mounted flat-panel detector to produce cone-beam volume CT images in the angiography suite¹. To clarify the anatomical relation of a vessel to vital structures, we employed DynaCT combined with low dose contrast material injection into the artery to create CT angiography-like images. DynaCTA produced images visualizing vessels in relation to bony landmarks as well as to coils and stents and affected our clinical decisions.

Technique

A flat-panel biplane angiographic system (AXIOM Artis FD Biplane Angiosuite; Siemens Medical Solutions, Forchheim, Germany) with DynaCT software was used. A DynaCT acquisition was obtained with the following parameters: 20-second rotation; 0.4° increment; 1024 x 793 matrix in projections at zoom 0 after resampling; 217° total angle; ~11°/s, ~27 frames/s, system dose 1.2 µGy/frame, total of 538 projections. This was combined with simultaneous injection of 5% contrast material at 1.5 ml/s from a guiding catheter or 60% contrast hand injection from a microcatheter. Images were automatically corrected for gain of the

image intensifier during the acquisition. Image reconstruction was performed on a commercially available workstation (X-Leonardo with DynaCT; Siemens Medical Solutions). The technique of injecting 5% contrast material at 1.5 ml/s from the guiding catheter was introduced to us by Dr. Michael E. Mawad.

Case Reports

Case 1

A 77-year-old man with a history of gunshot wound to the head presented with severe epistaxis. Workup CT revealed questionable pseudoaneurysm of the right cavernous segment internal carotid artery protruding into the sphenoid sinus. Alarmed by the massive hemorrhage, an emergent cerebral angiography was conducted under general anesthesia with a possibility to perform a carotid occlusion. Conventional DSA and 3D rotational DSA showed dysplastic dilatation and irregularity of the petrous and cavernous segment of the right internal carotid artery. However, on the angiography table, the question arose if this dilation was identical to the outpouching into the sphenoid sinus causing the epistaxis. DynaCTA was performed to clarify the internal carotid artery in relation to the sphenoid sinus. The images obtained by DynaCTA showed that the outpouching in the cavernous sinus was partially separated from the internal carotid artery by the lateral wall of the sphenoid sinus, and that there was a difference in density between the outpouching and the artery. Based on these findings, it was determined with confidence that the outpouching in the sphenoid sinus was not a pseudoaneurysm (Figure 1).

Case 2

A 63-year-old woman presented with an incidental, 20 mm, wide neck, basilar apex aneurysm incorporating bilateral P1 segments. A 4x20 (mm) Wingspan stent was placed across the aneurysm neck from the basilar artery to the right P1 segment in preparation for coiling. During the coiling, a double catheter technique was employed due to unstable initial framing coils. Because of the wide neck, an optimal biplane working position to clear bilateral P1 segments was impossible due to collision between the C-arms and the table. On conventional DSA, the initial coils seemed to be her-

niating out to the P1 segments. Therefore, a DynaCTA was performed to clarify the coils in relation to the stent and the P1 segments. The images showed that the coils were well framed within the aneurysmal sack, and the coils just covered the origin of the neck. The images provided information that as long as the subsequent coils were placed in this frame, the coiling would be safe. In addition, DynaCTA visualized the stent and microcatheters in good positions (Figure 2).

Case 3

A 12-year-old male with a midbrain arteriovenous malformation (AVM) had undergone three sessions of endovascular embolizations with sensory and motor evoked potential (SEP and MEP) monitors. At the last embolization, after 1 n-butyl-cyanoacrylate (NBCA) injection from a right medial posterior choroidal feeder, a small left medial posterior choroidal feeder was catheterized after much effort. Although SEP and MEP did not change with 20 mg of lidocaine infusion from the microcatheter, safety of embolization was in question because of proximal position of the microcatheter to the fistula. Therefore, a DynaCTA was performed with hand injection of 60% contrast from the microcatheter. This resulted in enhancement of midbrain tectum. The images provided information that this feeder provided normal brain tissue (parenchymal blush) (Figure 3), and embolization from this microcatheter position could potentially lead to tectal ischemia, thus the embolization was aborted.

Discussion

Optimal imaging study is crucial to successful endovascular procedures. However, this is not always possible due to limitations in time effectiveness and in the angiographic apparatus, such as restrictions in achieving optimal biplane working position or poor visualization of anatomical and endovascular structures surrounding the vessels by angiography. To overcome this drawback, we utilized DynaCT combined with contrast injection to create CTA-like image (DynaCTA). DynaCT is a new technology that uses a C-arm mounted flat-panel detector to produce cone-beam volume CT images in the angiography suite while the patient is on the table. Previous reports describe the significance of the timeliness and acceptable

Figure 1 A-C) Conventional CT axial and coronal views show the aneurysmal structure at the right cavernous ICA. D,E) Right internal carotid artery angiograms in anteroposterior and lateral views show dysplastic dilatation at the cavernous portion, which is difficult to correlate with the conventional CT. F-M) DynaCTA axial and coronal views demonstrating that the aneurysmal structure is separate from the ICA (arrows).

Figure 2 A,B) DSA of right vertebral artery in anteroposterior and lateral working positions showing incorporation of bi-lateral P1 segments which is difficult to see clearly. C,D) DSA of right vertebral artery after placing 2 framing coils using 2 microcatheters. Coils seem to be herniating out of the aneurysm. E-H) DynaCTA with right vertebral artery injection in oblique views with different contrast show that the coils are well retained in the aneurysm sac.

Figure 3 A,B) DSA of the left vertebral artery shows small midbrain AVM. C,D) Superselective angiogram of the left medial posterior choroidal artery shows arteriovenous shunting. The microcatheter is distal to the shunt, and safety of embolization from this position was in question. E-G) DynaCTA with injection of contrast from the microcatheter show enhancement of the brain parenchyma (arrows), indicating normal brain tissue supply from this pedicle.

image quality of the DynaCT in detecting intraprocedural complications and in visualizing intra- and extracranial stents¹⁻³, leading to improvements in patient management. Our report described three cases in which DynaCTA helped a better understanding of anatomy surrounding target vessels affecting our decision-making without causing significant delay.

In case 1, DynaCTA clarified bony structures and a cyst near a dysplastic ICA, which was difficult to appreciate on conventional DSA. There may be strong critics arguing why a conventional CTA was not performed before a cerebral angiogram, which would have definitely answered the above mentioned question. We must admit that the massive bleeding had misled our decision to perform an inappropriate emergent angiogram. Admitting that, we present case 1 to describe the usefulness of DynaCTA to overcome an error in a timely and seamless fashion. Although a CTA would have provided better quality information, transfer of a patient under general anesthesia from the angiography suite to a CT scanner would have required the time and efforts of many coworkers.

In case 2, DynaCTA reassured us with appropriate framing coils in a large wide-necked aneurysm coiling. Although a similar image may have been obtained by a 3D rotational angiogram, spatial resolution of the DynaCTA is better than with a 3D rotational angiogram. A 3D rotational angiogram requires high dose contrast injection for imaging, obscuring the contrast between endovascular devices such as coils and stents, and anatomical structures such as aneurysms and vessels. Especially, with low radiopacity nitinol intracranial stents, a conventional DynaCT has been reported with excellent ability of visualizing the apparatus²⁻⁴. In our case, with DynaCT combined with low dose contrast injection, the strut network is marginally visible (Figure 2 E,G) obscured by contrast injection. Nevertheless, the images confirmed the coil mass was outside the stent within the aneurysmal sac, which helped in continuing the procedure. In addition, low amount of contrast required in a DynaCTA may be helpful in cases with limitation in contrast dosage.

In case 3, embolization was aborted by the observation of brain parenchymal enhancement, and untoward ischemia was avoided. Although it can be argued that a careful review of a superselective angiogram would have been

sufficient to determine the safety of embolization, it is safer to have multiple means to solve a problem when in doubt.

In cases with difficult anatomy, DynaCTA can be a useful adjunctive technique for making appropriate clinical decisions. We emphasize that this technique is worth keeping in mind as an option in visualizing a vessel in relation to surrounding anatomy.

Conclusions

We describe three cases in which DynaCTA delineated the relation of the vessel in target with surrounding anatomy, affecting our clinical decisions. DynaCTA is a new technique combining DynaCT with simultaneous contrast injection to enhance visualization of vessels in relation to intracranial anatomical structures and endovascular devices. This technique can be a useful adjunctive tool in the angiographic suite that will aid in providing critical information instantly while the patient is on the angiography table.

References

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