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SNI: Neurovascular

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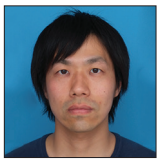
Case Report

Efficacy of ultra-high-resolution computed tomographic angiography for postoperative evaluation of intracranial aneurysm after clipping surgery: A case report

Shingo Kayano[1], Akira Ito[2], Toshiki Endo[2], Hitoshi Nemoto[1], Kazuki Shimada[1], Kuniyasu Niizuma[2,3,4], Teiji Tominaga[2]

[1]Department of Radiological Technology, Tohoku University Hospital, [2]Department of Neurosurgery, Tohoku University Graduate School of Medicine, [3]Department of Neurosurgical Engineering and Translational Neuroscience, Graduate School of Biomedical Engineering, Tohoku University, Sendai, Miyagi, Japan, [4]Department of Neurosurgical Engineering and Translational Neuroscience, Tohoku University Graduate School of Medicine, Sendai, Japan.

E-mail: Shingo Kayano - s_kayano@med.tohoku.ac.jp; *Akira Ito - akiraito@nsg.med.tohoku.ac.jp; Toshiki Endo - endo@nsg.med.tohoku.ac.jp; Hitoshi Nemoto - h-nemoto@rad.hosp.tohoku.ac.jp; Kazuki Shimada - kazuki.shimada.b7@tohoku.ac.jp; Kuniyasu Niizuma - niizuma@nsg.med.tohoku.ac.jp; Teiji Tominaga - tomi@nsg.med.tohoku.ac.jp



***Corresponding author:**
Akira Ito,
Neurosurgery, Tohoku University Graduate School of Medicine, Sendai, Miyagi, Japan.

akiraito@nsg.med.tohoku.ac.jp

Received : 29 November 2021
Accepted : 03 February 2022
Published : 11 March 2022

DOI
10.25259/SNI_1190_2021

Quick Response Code:

ABSTRACT

Background: Following clipping surgery for intracranial aneurysm, computed tomography angiography (CTA) is often used to confirm complete aneurysm obliteration. However, artifacts from the titanium clips usually degrade the images around them. The ultra-high-resolution computed tomography (UHR-CT) system recently became available in clinical practice. Here, we report a case in which CTA using the UHR-CT system successfully pointed out a small aneurysmal remnant after the clipping surgery, which was validated by digital subtraction angiography.

Case Description: A patient underwent clipping surgery for an unruptured aneurysm using two titanium alloy clips. CTA using the UHR-CT system demonstrated a small remnant aneurysm. Digital subtraction angiography confirmed the minor remnant. The UHR-CTA images were comparable to three-dimensional reconstructed images from the rotational angiography.

Conclusion: We propose that UHR-CTA is a reliable postoperative assessment method for intracranial clipping surgeries.

Keywords: Cerebral aneurysm, Computed tomography angiography, Digital subtraction angiography, Ultra-high-resolution computed tomography

INTRODUCTION

Clipping surgery is one of the established treatments for intracranial aneurysms.[3] Digital subtraction angiography (DSA) has long been considered the gold standard for examining cerebral aneurysms.[2,6] Recently, computed tomography angiography (CTA) has more frequently been used to evaluate aneurysms, especially after clipping surgeries.[1] However, aneurysmal clips induce metal artifacts in CTA, which hinder precise evaluations of aneurysms.[4,6]

The ultra-high-resolution computed tomography (UHR-CT) system recently became available, and we recently reported usefulness of UHR-CT in the detection of the subcallosal artery.[5] UHR-CT theoretically reduces metal artifacts. Here, we report a case of the successful detection

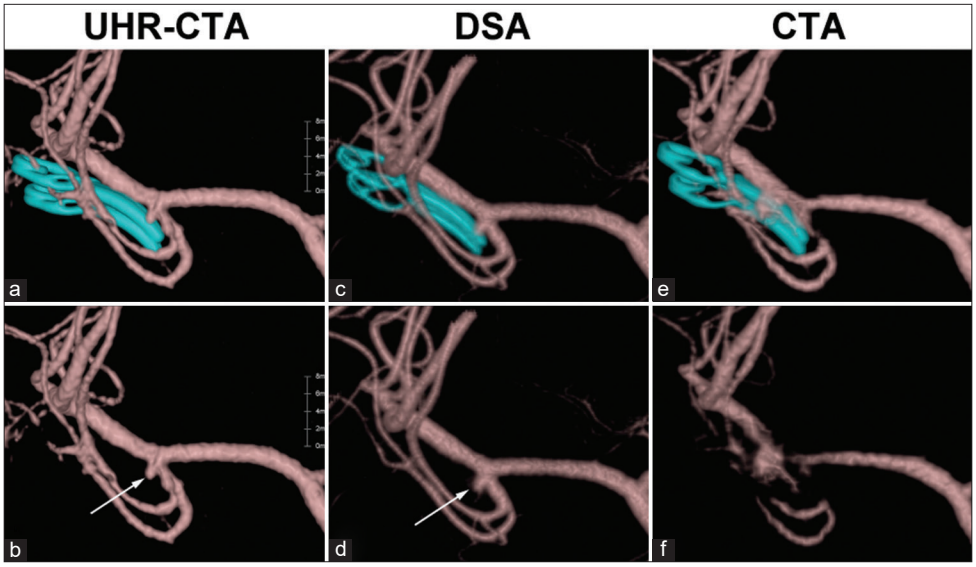


Figure 1: Small recurrent aneurysm after the clipping surgery. The volume rendering image on (a and d) ultra-high-resolution computed tomographic angiography (UHR-CTA) is comparable to (b and e) on digital subtraction angiography (DSA), and (c and f) on conventional CTA. The image from conventional CTA had considerably less optimal quality. The aneurysmal clips were removed manually in (d, e and f). Note that UHR-CTA and DSA were performed in 2020, whereas conventional CTA was performed in 2019. Arrows in (d and e) indicate small remnant of the aneurysm after clipping surgery.

of a minor remnant of an aneurysm using UHR-CTA after clipping surgery.

CASE DESCRIPTION

A patient underwent clipping surgery for an unruptured aneurysm. Two titanium alloy clips (Sugita Aneurysm Clip; Mizuho, Tokyo, Japan) were used for obliteration of the aneurysm. He/she underwent CTA using the UHR-CT system (Aquilion Precision; Canon Medical Systems, Otawara, Japan) after surgery [Figure 1a]. The scanning protocol was same as previously reported (supplementary manuscript).[5] The obtained image demonstrated a small bulge, indicating a possible remnant aneurysm. DSA using a biplane angiography system with flat-panel detectors (Infinix Celeve-I INFX8000V, Canon Medical Systems) confirmed the minor rem€nant. Three-dimensional reconstructed images from the rotational angiography were comparable to the UHR-CTA images [Figures 1b-e]. A CTA image obtained on conventional CT system (Aquilion ONE ViSION Edition; Canon Medical Systems) was much less optimal to detect the remnant [Figure 1].

Phantom study

Using the same scanning parameters for UHR-CTA and conventional CTA, we performed the phantom studies (supplementary manuscript). The *in vitro* study demonstrated that the artifacts from the aneurysmal clip were less intense the image obtained in UHR-CT [Figure 2a] than that in conventional CT [Figure 2b].

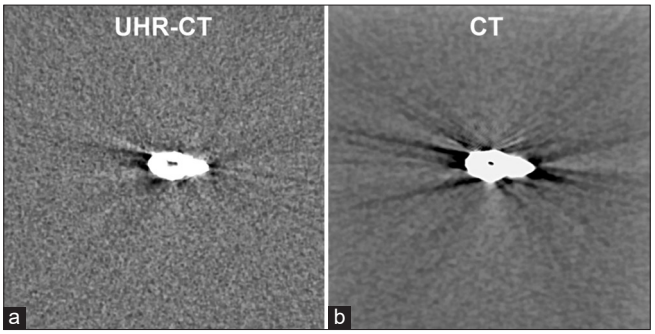


Figure 2: *In vitro* study comparing ultra-high-resolution computed tomography (UHR-CT) and conventional CT. The artifacts from the aneurysmal clip were suppressed in (a) UHR-CT, whereas it was more intense in (b) conventional CT.

DISCUSSION

This is the first report demonstrating the efficacy of UHR-CTA in evaluating aneurysms after clipping surgery, which successfully suppressed the artifacts from the clips.

The UHR-CT system has two distinct features that explain the quality improvement. First is the high spatial resolution. UHR-CT can provide images with a matrix of 1024 × 1024 and 0.25 mm section thickness,[7] which is twice the capabilities of conventional CT. Second is the high-effective energy of the X-rays. Our results, measured using the noncontact-type X-ray analyzer, showed the effective X-ray energy at 120 kV as 55.9 keV and 48.8 keV in the UHR-CT and conventional CT used at our institute, respectively (unpublished data).

A recent meta-analysis indicated that CTA was not as accurate as DSA in ruling out postclipping remnant aneurysms;[6] the reason is metal artifacts from titanium clips, which always matter in postoperative evaluations.[4] The current case report highlights that UHR-CTA is comparable with DSA in evaluating intracranial aneurysms even after the titanium clips were placed.

Acknowledgments

The authors would like to thank Enago (www.enago.jp) for the English language review.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Golitz P, Struffert T, Ganslandt O, Lang S, Knossalla F, Doerfler A. Contrast-enhanced angiographic computed tomography for detection of aneurysm remnants after clipping: A comparison with digital subtraction angiography in 112 clipped aneurysms. Neurosurgery 2014;74:606-13.
2. Kaufmann TJ, Huston J 3rd, Mandrekar JN, Schleck CD, Thielen KR, Kallmes DF. Complications of diagnostic cerebral angiography: Evaluation of 19, 826 consecutive patients. Radiology 2007;243:812-9.
3. Molyneux AJ, Kerr RS, Yu LM, Clarke M, Sneade M, Yarnold JA, *et al.* International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: A randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion. Lancet 2005;366:809-17.
4. Sakuma I, Tomura N, Kinouchi H, Takahashi S, Otani T, Watarai J, *et al.* Postoperative three-dimensional CT angiography after cerebral aneurysm clipping with titanium clips: Detection with single detector CT. Comparison with intra-arterial digital subtraction angiography. Clin Radiol 2006;61:505-12.
5. Sato Y, Endo T, Kayano S, Nemoto H, Shimada K, Ito A, *et al.* Comparison between ultra-high-resolution computed tomographic angiography and conventional computed tomographic angiography in the visualization of the subcallosal artery. Surg Neurol Int 2021;12:528.
6. Uricchio M, Gupta S, Jakowenko N, Levito M, Vu N, Doucette J, *et al.* Computed tomography angiography versus digital subtraction angiography for postclipping aneurysm obliteration detection. Stroke 2019;50:381-8.
7. Yanagawa M, Hata A, Honda O, Kikuchi N, Miyata T, Uranishi A, *et al.* Subjective and objective comparisons of image quality between ultra-high-resolution CT and conventional area detector CT in phantoms and cadaveric human lungs. Eur Radiol 2018;28:5060-8.

How to cite this article: Kayano S, Ito A, Endo T, Nemoto H, Shimada K, Niizuma K, *et al.* Efficacy of ultra-high-resolution computed tomographic angiography for postoperative evaluation of intracranial aneurysm after clipping surgery: A case report. Surg Neurol Int 2022;13:85.

Supplementary Manuscript

The following scanning parameters were used for the ultra-high-resolution computed tomography angiography (CTA): tube voltage = 120 kV, tube current = 240 mA, collimation = 0.25 mm × 160, beam pitch factor = 0.569, rotation speed = 0.75 s, slice thickness = 0.25 mm, slice interval = 0.25 mm, scanning FOV = 320 mm, and reconstruction kernel = forward-projected model-based iterative reconstruction solution (FIRST) algorithm. The image matrix size was 1024 × 1024 matrix and display field of view (FOV) of 200 mm.

The conventional CT scanning parameters were as follows: tube voltage = 120 kV, collimation = 0.5 mm × 320, 1.5 s/rot, slice thickness = 0.5 mmSR, slice interval = 0.25 mm, scan coverage = 160 mm of volume per rotation, and reconstruction kernel = FC44. Scanning FOV = 240 mm. CT-AEC was set on the condition that the standard deviation of 0.5 mm thickness images was equal to 7. Iterative and noise-reduction filters (AIDR3D enhanced mild), and a single energy metal artifact reduction algorithm were applied. The display FOV was 200 mm.

The above scanning parameters are used in the proposed phantom study and the clinical evaluations of the cerebral CT angiography in our institute.