The Accuracy and Usefulness of 3D-DSA and 3D-CT Angiography for Cerebral Aneurysms

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Summary

For evaluation of intracranial cerebral aneurysms, three-dimensional (3D) digital subtraction angiography (DSA) and 3D-computed tomographic angiography (CTA) were demonstrated in fifteen patients. The diagnostic accuracy of preoperative 3DCTA is equal to that of 3D-DSA except for the case with a dissecting aneurysm. The virtual images of 3D-CTA were well correlated with surgical findings. In endovascular treatment of intracranial aneurysms, 3D-DSA had an obvious advantage in obtaining the best working angle of the C-arm. The major branches originating from the dome were depicted on 3D-DSA in two cases that could not be judged on 3D-CTA. The aim of the present study was to verify the difference between 3D-DSA and 3D-CTA for evaluation of intracranial aneurysms.

Introduction

The development of 3D images acquired using magnetic resonance angiography (MRA), CTA and DSA, have enabled more accurate

evaluations of intracranial aneurysms. The usefulness of each 3D images has been reported by some authors^{2,3,4,5,6,7,8}; however, no studies have evaluated the difference in usefulness between 3D-CTA and 3D-DSA. In this study, we investigated the accuracy and usefulness of 3D-DSA for intracranial aneurysms compared to 3D-CTA.

Clinical Material and Methods

Patients

Fifteen patients (6 men and 9 women; mean age, 58 years) with a total of 18 intracranial aneurysms were enrolled in this study. The locations, treatments and presentations of subarachnoid hemorrhage are listed in table 1. In all patients 3D-CTA and 3D-DSA were performed within three days of each other, and all aneurysms were treated with a surgical procedure such as neck clipping and trapping with bypass or embolization with Guglielmi detachable coils (GDCs).

Figure 1 A 59-year-old man with angiogram negative-SAH was referred to our hospital. One week later 3D-CTA revealed a basilar trunk aneurysm. Three-dimensional DSA showed a similar 3D image and this aneurysm was confirmed during surgical exposure.

Figure 2 The patient was a 52-year-old woman who experienced sudden onset left oculomotor nerve palsy. Three-dimensional CTA revealed a left IC-PC aneurysm with two blebs near the neck (Left). These blebs were depicted with 3D-DSA (Center) and this image was well correlated with surgical findings (Right).

3D-DSA

All patients underwent fast rotational spin angiography using an Advantx LCN Puls DSA unit (General Electric). Fast rotational spin angiography was performed with a 200-degree rotation of the C-arm in 5 seconds. The exposure was 8.8 frame per second and each frame had 512×512 pixels. Fifteen to 20 ml of contrast material was injected via a selected positioned catheter. Three-dimensional surface or volume rendering images were made using an Advantage 3.1 workstation (General Electric).

3D-CTA

Three-dimensional CTA was performed using a high-speed helical scanner (TOSHIBA X-vigor). CT scanning began after an 100-ml intravenous bolus injection of nonionic contrast medium iopamidol 300 (Nippon Schering, Osaka, Japan) at 2ml/second with a 20-second pre-scanning delay.

About sixty scans of the prescribed areas on lateral scout views were obtained in 1-mm slices by using a 1-mm/second table speed. Three-dimensional reconstructions of the im-

Figure 3 Three-dimensional DSA revealed a left vertebral dissection aneurysm. The false lumen was diagnosed clearly observed and it extended from just proximal to the left posterior-inferior cerebellar artery to the union of the vertebral artery. Auto-positioning function provided the best working angle for embolization of the left VA with GDCs (Right).

Figure 4 Left IC-PC aneurysm could not be diagnosed with DSA (Left); however the posterior communicating artery from the dome was imaged using 3D-DSA (Center) and an endoscopic image on 3D-CTA (Right).

Figure 5 The neck remnant of a right IC-PC aneurysm treated with a titanium clip was evaluated using 3D-DSA (A) and 3D-CTA (B). Both 3D-images depicted a small proximal neck remnant.

ages were conducted to overlap 0.5-mm sections for increased resolution by using a workstation with three-dimensional imaging software (TOSHIBA Xtension V2.01).

Results

Surgical procedures were performed in 8 patients. Preoperative 3D-DSA images revealed all aneurysms as similar to the surgical findings. The minimum dome diameter was observed in a patient diagnosed angiogram negative-SAH. Both 3D-DSA and 3D-CTA had the same accuracy in diagnosing aneurysm in terms of neck diameters as small as 2mm (figure 1). Blebs on aneurysmal dome were detected in two patients during surgery. These blebs could be evaluated with both 3D-CTA and 3D-DSA (figure 2).

Treatment for intracranial aneurysms with

GDCs included aneurysmal sac embolization and vertebral artery occlusion. Auto-positioning function of the C-arm was utilized in all cases to determine best working angle (figure 3). The operator selected one of the 3D surface or volume rendering images that were made for separating the parent artery from the neck, and the Workstation automatically set up at the best working angle. By using this function, contrast material was not wasted and determining the most appropriate angle of the C-arm was quick and simple. In addition, to diagnose a left vertebral dissecting aneurysm, 3D-DSA was more optimal than 3D-CTA (figure 3): 3D-DSA depicted the dissecting space more clearly than 3D-CTA.

In two cases, it was difficult to judge the origin of the major branch with both DSA and 3D-CTA; however, 3D-DSA and endoscopic images from 3D-CTA made it possible to diag-

Table 1 Summary of patients

Case	age/gender	location	SAH	treatment
1	59 M	Basilar trunk	+	Neck clipping
2	45 M	Basilar trunk	+	-
3	52 F	Lt. ICPC	-	Neck clipping
4	51 M	Lt. VA dissecting	+	Endovascular
5	42 F	Bil. IC ophthalmic	-	Endovascular
6	61 F	Lt. ICPC	-	Endovascular
7	77 F	Rt. ICPC	+	Neck clipping
8	67 F	Rt. IC bifurcation	-	Endovascular
9	53 F	Bil. MCA/Basilar top	+	Neck clipping
10	69 M	Lt. ICA	-	Endovascular
11	49 F	Rt. ICA	-	Endovascular
12	69 M	Lt; VA-PICA	-	Surgery w/ bypass
13	57 F	Lt. ICA	-	Endovascular
14	63 M	Acom complex	-	Surgery w/bypass
15	53 M	Lt. MCA	-	Neck clipping

nose whether the major branch exited from the dome or parent artery (figure 4).

Three-dimensional DSA was useful to evaluate the neck remnant in patients undergoing surgical procedure, and even in the aneurysm treated with a non-titanium clip, 3D-DSA provided more useful information than DSA. In two patients whose aneurysm was obliterated with a titanium clip, 3D-CTA revealed the parent artery and titanium clip at the same time, but 3D-CTA tended to evaluate the parent artery as narrower. In one patient a neck remnant was correctly evaluated with both 3D-DSA and 3D-CTA (figure 5).

Discussion

For the evaluation of intracranial aneurysms, DSA remains the "gold standard", and the diagnostic accuracy of 3D-images has developed rapidly. However, silent embolism in diagnostic cerebral angiography was reported and embolic events were more frequent than the apparent neurological complication rate¹. On the other hands, some authors reported the useful of 3D-DSA, but 3D-DSA is invasive and more expensive than DSA. Thus in these regards, 3D-CTA had an obvious advantage and it can be performed without hospitalization. In this study, we investigated the accuracy usefulness of 3D-DSA for intracranial aneurysms in comparison with 3D-CTA.

The depiction of aneurysm in relation to blebs on aneurysmal dome is important information for both surgical and endovascular treatment and in this regard, 3D-DSA evaluated aneurysms as well as accurately as 3D-CTA. In this study, blebs on aneurysmal dome were revealed in two patients surgically; however, preoperative 3D-CTA revealed the aneurysmal blebs and both 3D-images were well correlated with each other. In addition, using 3D-CTA a precise assessment of other surrounding struc-

tures such as the anterior clinoid process, veins and sinus, could be made, and in creating a virtual image including these components for aneurysm surgery, 3D-CTA was superior to 3D-DSA⁸.

The smallest aneurysm detected with 3D-CTA was 2.0 mm and located at the basilar artery. This finding is consistent with previous studies and 3D-DSA had the same accuracy by means of 3D-CTA in the points of the lower limit of aneurysm detection^{2,3,6}.

It is necessary to determine the best working angle for endovascular treatment of intracranial aneurysms and for this purpose, 3D-DSA with auto-positioning function is an essential modality for endovascular treatment. The position of the C-arm using the information provided by 3D-DSA was well correlated with the actual working angle and 3D-DSA had a satisfactory ability to image major artery branches of intracranial aneurysms.

Based on the findings in this study, we consider that 3D-DSA is a more useful modality for endovascular treatment than 3D-CTA and that in particular, the auto-positioning function of the C-arm is an essential tool. However, 3D-CTA was the optimal examination for the detection of aneurysms in patients scheduled for surgical treatment and for the postoperative evaluation of aneurysm treated with titanium clip.

Conclusions

The diagnostic accuracy of 3D-DSA is equal or superior to that of 3D-CTA, however, 3D-CTA would also be useful for the precise assessment of aneurysm surgery except for special cases.

However 3D-DSA had an obvious advantage in the evaluation of aneurysms treated with GDC. Considering the cost and invasion of DSA, we should make the proper use of 3D-DSA in every case.

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