Many asymptomatic, unruptured intracranial aneurysms (UIAs) are found by MR angiography or CT angiography during the physical checkup. The International Study of Unruptured Intracranial Aneurysms (ISUIA) emphasize that among patients with unruptured aneurysms and no history of subarachnoid hemorrhage, aneurysmal size at the time of discovery is the most important variable determining the risk of future rupture. We use three-dimensional CT angiography (3-D CTA) to measure the size and morphological characteristics of the aneurysm, according to the standards of ISUIA. Twenty two UIAs were found in 20 patients; 8 aneurysms were smaller than 2 mm, 2 aneurysms were 2 mm and no one was larger than 6mm. The sizes of all UIAs were rechecked by both volume rendering 3-D CTA and post-contrast 2-D reformatted CT images; the measured diameter is almost the same by both methods. We find 3-D CTA has a good quality to measure the size and morphological characteristics of the aneurysm, even in aneurysm smaller than 2 mm.

The prognosis of subarachnoid hemorrhage caused by ruptured intracranial aneurysm is still poor even in this era with improved microsurgery and endovascular coiling technique. Improvements in CT and MRI angiography over the past two decades have led to a large increase in the detection of incidental aneurysms. However, the management of unruptured intracranial aneurysm (UIA) remains controversial because of conflicting data about the natural history of these lesions and the risks associated with their treatment. Most neurologists [1] favored that incidentally discovered aneurysms in the anterior circulation less than 7 mm in size in people with no personal or family history of subarachnoid hemorrhage should be left untreated. However, some neurosurgeons [2] thought the treatment for small, asymptomatic aneurysms should depend on multiple factors: “size isn’t everything”. We found a lot of unruptured intracranial aneurysms during physical checkup and most of them were smaller or equal to 2 mm in size. We define small aneurysm as the aneurysm’s largest diameter is smaller or equal to 2 mm, because International Study of Unruptured Intracranial Aneurysms Investigators (ISUIA) excludes all aneurysms smaller than 2 mm. We review the literature and make a diagnosis and treatment policy.

MATERIALS AND METHODS

We use GE Company Light Speed VCT to do the three-dimensional CT angiography (3-D CTA) for brain vessels. We use Omnipaque™ for contrast medium and Mallinckrodt OptiVantage™ DH for injector. The injection rate is 4cc/sec. We use Smart Prep technique to initiate the scan and choose the aortic arch as the region of interest (ROI), and the threshold of 80 Hounsfield Units (HU). The SFOV is 32cm, and the collimation section is 0.625mm. All the data of 3-D CTA are collected by two well-trained radiological technicians. They use GE
Advantage Workstation 4.3 to handle all the data. The results of 3-D CTA are reviewed by one radiologist and one neurosurgeon. We reviewed the standards of International Study of Unruptured Intracranial Aneurysms Investigators (ISUIA) [3] first, and made a standard for our 3-D CTA. If there is any disagreement between the radiologist and neurosurgeon, we review all the CTA data together, and make a final conclusion using the standards.

According to the standards of ISUIA, the maximum diameter reported for an intracranial aneurysm is the largest measurement in any one of the three film planes (ie, anteroposterior, mediolateral, or cephalocaudal). Diameters are measured to the nearest millimeter, because by catheter cerebral angiography the range of error induced by geometric distortion far exceeds specific submillimeter direct measurements from hard copy. Four morphologic classifications are used in the ISUIA: 1. a single sac with a smooth margin; 2. a single sac with an irregular corrugated margin; 3. a primary sac with a daughter sac; and 4. a multilobed structure. The location of the aneurysm is defined in terms of the junction of a secondary vessel arising from a parent vessel.

Using our 3-D CTA, we can make a multi-plane rotation in our workstation (Fig. 1) to find the aneurysm. We can measure the largest diameter of the found aneurysm, without needing cerebral angiogram magnification/minification ruler. For measuring the diameter of the UIA, we first rotate the plane of volume rendering 3-D CTA until the largest diameter of the found aneurysm appears (Fig. 2). Then, we reformat the post-contrast 2-D CT images and rotate the plane of interest until the largest diameter of aneurysm appears again (Fig. 3). We compare measured diameters of the found aneurysm between these two images and record the data. We can measure the diameter of the found aneurysm to the specific submillimeter accurately. For future follow up, we also measure the neck to dome distance of the aneurysm, which is not measured in ISUIA standard.

We found many infundibulum (junction dilatation) and we excluded them from our study. We defined infundibulum as an arterial pouch less than 3mm and with a secondary vessel directly arising from its apex.

RESULTS

From November 2006 to August 2007, 410
adults received 3-D CTA for brain vessels during their physical checkup. In total 410 adults receiving our 3-D CTA study, 6 of them had severe skin rash, and 4 of them need antihistamine injection; all had no sequelae. One had venous leakage, and only topical treatment was given.

Twenty two unruptured incidental aneurysms were found in 20 patients. Two patients had double aneurysms. Eight aneurysms were smaller than 2 mm, 2 aneurysms were 2 mm and no one was larger than 6mm. All of our UIAs were exclusively smooth sac, as we rechecked the post-contrast 2-D reformatted CT images and volume rendering 3-D CTA images.

The aneurysms were located as follows: Internal carotid artery, 8; Posterior communicating artery, 6; Anterior communicating artery, 3; Anterior cerebral artery, 2; Middle cerebral artery, 1; Basilar artery, 2.

The measured largest diameter from volume rendering 3-D CTA is almost the same as the measured diameter from post-contrast 2-D reformatted CT images. The mean value of largest diameter measured by volume rendering 3-D CTA is $2.28 \pm 0.58$ mm, and $2.30 \pm 0.58$ mm as measured by post-contrast 2-D reformatted CT images; the P-Value is 0.317 between these two methods. The mean value of largest neck to dome distance measured by volume rendering 3-D CTA is $1.85 \pm 0.77$ mm, and $1.86 \pm 0.78$ mm as measured by post-contrast 2-D reformatted CT images; the P-Value is 0.317 between these two methods too. Only one case the measurement is different between these two methods, and the possible reason is that the contrast medium is insufficient (180 HU in this case compared with 350 HU averagely) during the procedure.

**DISCUSSION**

One of the largest series for natural history of UIA was International Study of Unruptured Intracranial Aneurysms Investigators (ISUIA) [4]. All their patients underwent catheter cerebral angiography. They made conclusion: “asymptomatic patients with incidentally discovered aneurysms less than 7 mm in diameter in the anterior circulation have a very low risk of rupture”. They also suggested that one must be particularly thoughtful regarding surgical repair of UIAs in patients more than 50 years of age and endovascular repair in patients more than 70 years of age. The acceptance of these results by salaried surgeons was substantially greater than those working in a fee-for-treatment environment. However, their study excluded aneurysms with a maximum diameter less than 2 mm; in addition, in the observation group of total 1692 patients, 534 patients were removed from follow-up because they had treatment, including 410 patients had surgery and 124 patients had endovascular treatment. These patients were censored and little information was mentioned in that paper.

Many neurosurgeons have different opinions about the treatment for UIAs. Bryce Weir [5] made a strong opposition: “Annually, more than 15000 American patients have subarachnoid hemorrhage (SAH) from aneurysms with a maximum diameter less than 7 mm and consequently experience irreparable morbidity and mortality. The majority of their aneurysms were unruptured, single, asymptomatic, and even smaller at some point before rupture”.

In our institution, from Nov. 2006 to August 2007, 22 asymptomatic, unruptured intracranial aneurysms were found by 3-D CTA. For following up their aneurysms, we reviewed the standards of ISUIA and adjusted their recording parameters to our CTA. In the ISUIA, Glenn Forbes et al conducted a study to establish methods to evaluate angiograms with regard to the size, location, and
other angiographic characteristics of aneurysms. However, due to limitation of cerebral angiography, they excluded aneurysms with a maximum diameter less than 2 mm. Actually, many asymptomatic, unruptured intracranial aneurysms (UIAs) found by MR angiography or CT angiograph were smaller than 2 mm and in the long term follow-up, these aneurysms did grow up and even rupture. From Nobuyuki [6] series, 360 UIAs were treated conservatively, 25 were readmitted because of rupture and 6 of them were smaller than 2 mm initially. From Nobuhiko [7] series, 130 patients with unruptured aneurysms identified by MRA underwent MRA twice or more; 14 had aneurysms growth more than 2 mm and 4 of them were smaller than 2 mm initially.

Our 3-D CTA done by Light Speed VCT can give collimation section about 0.625 mm, therefore we can accurately found aneurysm smaller than 2 mm. In our series, 8 of 22 UIAs were smaller than 2 mm and 2 were 2 mm. None of all 22 UIAs was larger than 6 mm. In the prospective series of ISUIA, 1049 of 1692 patients (62 %) had aneurysm smaller than 7 mm, and they excluded aneurysms smaller than 2 mm, the numbers of this latter group maybe even more than 1049; therefore, most of UIAs were small.

In addition, all of our UIAs were exclusively smooth sac, maybe due to limitation of CTA. However, we reconstruct the images from very thin collimation, and the picture should be accurate. After all, we think the smooth sac is a benign picture, indicating no previous rupture and less future rupture. Of course, these need further follow up too.

Before 2000 [8], the sensitivity of CTA for detection of aneurysms larger than 3 mm was about 96%, and 61% for aneurysms 3 mm or smaller. However the collimation section was about 2 to 3 mm at that time. Because the improvement of technology and resolution for 3-D CTA, the collimation section is less than 1 mm later, and the accuracy for detecting small aneurysm is increasing. The recent report [9] for detection of cerebral aneurysms smaller than 5 mm revealed sensitivity of CTA ranged from 98% to 100%, compared with 95% for digital substraction angiography (DSA), and the specificity of CTA and DSA was 100%. We use GE Light Speed VCT, and it can give a thinner collimation for CTA. Therefore, our CTA should have a higher accuracy.

We agree that in very-low risk aneurysms the risks of treatment outweigh the benefits at all ages. However, it is very important to consider the patient’s perspective regarding his or her desire to have the aneurysm treated even with the low risk of rupture. In addition, we also should consider the influence of UIA to the patient’s psychological reaction. Therefore, we inform all the patients with UIA about the very low risk of rupture. Because all our UIAs are asymptomatic and smaller than 6 mm in largest diameter, we do not consider any treatment, and we do not arrange conventional angiography to prove the diagnostic accuracy. We just suggest that all the patients should be followed up for their UIAs. For cost and effect, we set a protocol to regularly follow up all their UIAs by 3-D CTA annually for 3 years.

CONCLUSION

3-D CTA is a good screening method for UIA. It can correctly diagnosis small aneurysm, even less than 2 mm in diameter. If an aneurysm is found, and no risk of rupture is noted, we suggest follow-up annually for 3 consecutive years.

REFERENCES


由三度空間電腦斷層血管攝影發現小的、無症狀且未破裂的顱內動脈瘤

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很多無症狀，未破裂的顱內動脈瘤在健康檢查時，被核磁共振血管攝影或電腦斷層血管攝影發現。未破裂顱內動脈瘤國際性研究 (ISUIA) 強調，對於這類病人，如果沒有蜘蛛膜下腔出血的病史，被發現時動脈瘤的大小是決定它們是否會破裂的最重要因子。我們採用未破裂顱內動脈瘤國際性研究的標準，利用三度空間電腦斷層血管攝影 (3-D CTA) 來測量未破裂顱內動脈瘤的大小及形狀特徵。總共有二十位病人及二十二個未破裂顱內動脈瘤被發現，其中八個動脈瘤小於兩毫米，二個動脈瘤等於兩毫米，且所有病人都小於六毫米。我們同時使用三度空間電腦斷層血管攝影影像及二度空間電腦斷層影像，來確認動脈瘤的大小。我們認為三度空間電腦斷層血管攝影在測量未破裂顱內動脈瘤的大小及形狀特徵上有很好的品質，甚至對於小於兩毫米的動脈瘤也很準確。