Radiological measurements of dimensions of acutely ruptured internal carotid artery aneurysm: a comparative study between computed tomographic angiography and digital subtraction angiography

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Abstract

After aneurysmal subarachnoid hemorrhage, most center practices treatment modality selection based on size and geometry in computed tomographic angiography. However, the validity as compared to digital subtraction angiography (DSA) is not well studied. Twenty patients with ruptured internal carotid artery aneurysm were identified in a two-year period. Mean difference in measurements from 3D computed tomographic angiography (3D-CTA) and 3D-DSA were less than 1 mm and 3D-DSA measurement did not alter the decision to proceed for endovascular embolization. With modern multislice computed tomography technology, good quality 3D-CTA alone would be sufficient to make size and geometry assessment for treatment selection for patients with ruptured internal carotid artery aneurysm.

Introduction

Ruptured intracranial aneurysms account for up to 90% of patients presented with spontaneous subarachnoid hemorrhage. Early and prompt occlusion or obliteration of the ruptured aneurysm is a crucial part of modern management to prevent rebleeding and to facilitate treatment of cerebral vasospasm. Three-dimensional computed tomographic angiography (3D-CTA) has been established as the first line radiological investigation for patients presented with spontaneous subarachnoid hemorrhage since the era of helical scanner.[1,2] With the advancement in multislice computed tomography and refinement in software, its role as first line diagnostic tool has been firmly established.[3-6] With the data coming out from International Subarachnoid Aneurysm Trial (ISAT),[7] endovascular coiling would be the preferred method for aneurysm occlusion if size and geometry of the intracranial aneurysm is favorable. If geometry is not favorable or in cases of peripherally located aneurysm as middle cerebral artery aneurysm, microsurgical clipping would be advised. The decision based on geometry would be more crucial in patients with ruptured posterior communicating artery aneurysm as microsurgical clipping could be carried out with low morbidity and mortality. It would be important to know in this respect whether 3D-CTA alone is a good tool to select treatment modality based on size and geometry as compared to three-dimensional rotational digital subtraction angiography (3D-DSA).

Materials and Methods

We carried out the study in a regional neurosurgical center in Hong Kong. Our unit has installed the multi-slice computed tomography machine (GE LightSpeed 16, GE Healthcare, Waukesha, WI, USA) and it was in service since January 2004. For 3D-CTA, slices parallel to orbito-meatal line were obtained in caudo-cranial direction starting from 1cm below the base of sella turcica up to the level of lateral ventricles. Slice reconstruction thickness was 0.625 mm. One hundred ml non-ionic contrast medium (Omnipaque 300, GE Healthcare) was administered through a 20 G needle from the antecubital vein with a rate of 3-3.5 mL/s. Acquisition of images started after 20 s and 3D-CTA examination lasted for about 40-60 s. The 3D-DSA was carried out with the biplane DSA machine with rotational DSA function (Philips V5000, Amsterdam, The Netherlands) and was done with nonionic contrast medium (Omnipaque 300, GE Healthcare) 2-2.4 mL/s with a total injection volume of 15-18 mL. The 3D-DSA was performed with a C-arm rotation of 180 degree. We prospectively identified patients with ruptured internal carotid artery (ICA) aneurysm with both 3D-CTA and 3D-DSA obtained in a 24-month period. All the measurements were carried out by the first author (Wong GK) and recorded for analysis. The measurements were obtained from both 3D-CTA and 3D-DSA. The measurements included length of aneurysm, neck of aneurysm, diameter of internal carotid artery just posterior to the origin of posterior communicating artery (ICA diameter) and aspect ratio. 3D-CTA and 3D-DSA measurements were carried out by a vascular neurosurgeon and an interventional radiologist respectively. In this patient cohort, microsurgical clipping cases were carried out through standard pterional craniotomy and endovascular embolization cases were carried out without the use of balloon and stent. The statistical analysis was carried with SPSS Version 14.0.

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Results

A total of twenty patients with ruptured internal carotid artery aneurysm was identified. Male to female ratio was 1 to 4. Mean age was 63 years, ranged from 42 to 86 years. Three patients did not have CTA performed before DSA. Four patients had poor intracranial vessel filling as noted with unidentifiable Circle of Willis. They were excluded from analysis. The length of the aneurysm (mean±SD) as measured by DSA was 5.6±1.5 mm. The neck of the aneurysm (mean±SD) as measured by DSA was 3.6±1.4 mm. With measurements obtained from coupled 3D-CTA and 3D-DSA, differences for measurements (between 3D-CTA and 3D-DSA) of internal carotid artery diameter posterior to the origin of posterior communicating artery (ICA diameter), aneurysm neck and aneurysm length were compared. The difference in ICA diameter (mean±SD, 95% CI) was 0.1±0.4 mm, -0.3 mm to 0.2 mm. The difference in aneurysm neck (mean±SD, 95% CI) was 0.8±1.1 mm, 0.1 mm to 1.5 mm. The difference in aneurysm length (mean±SD, 95% CI) was 0.7±-1 mm, 0.1 to 1.3 mm. The data on aspect ratios[8] were compared between 3D-CTA and 3D-DSA measurements. Three patients with a 3D-CTA-measured aspect ratio of 1.5 to 2 were noted to have aspect ratio of >2 on 3D-DSA. One patient with a 3D-CTA-measured aspect ratio of >2 was noted to have aspect ratio of 1 to 1.5 on 3D-DSA. The decision to proceed for endovascular embolization or microsurgical clipping was not altered by information obtained from 3D-DSA

Discussion

In this case series, mean difference in measurements from 3D-CTA and 3D-DSA were less than 1 mm and 3D-DSA measurement did not alter the decision to proceed for endovascular embolization. The data showed that 3D-CTA is useful in treatment modality selection in patients with ruptured internal carotid artery aneurysm. As technology progresses, the sensitivity and specificity of multislice 3D-CTA for cerebral aneurysms (ruptured and unruptured) is rapidly approaching that of gold standard digital subtraction angiography (DSA).[3-6] The advantage of 3D-CTA are that, compared with DSA, it is noninvasive, it can be performed much more quickly, it requires less resources (staffing and equipment), minimal neurological complication; thus, it is more suitable in this group of critically ill patients. Advantage of 3D-CTA also included assessment of the aneurysm in relationship to the skull base structures such as anterior clinoid process and sella turcica. Radiation dose in 3D-CTA is more than routine cranial computed tomography but significantly less than DSA. In patients with a large hematoma, 3D-CTA is a rapid study that can be performed at the time a head computed tomographic scan is obtained, which allows for rapid operative management without delay. With these, 3D-CTA had replaced DSA as the initial radiological investigation for diagnosis and treatment selection.

Selection of treatment modality for aneurysm obliteration or occlusion has been a controversial topics since the approval of Guglielmi detachable coil embolization. The result of the ISAT, which involved 2143 patients in centers mainly in UK and Europe, showed that in patients suitable for either endovascular embolization or microsurgical clipping because of relative safety and efficacy of these approaches, endovascular embolization was more likely to result in independent survival at one year and the benefit continued for at least seven years.[7] With these data and underlying logics in mind, it would rephrase into saying that it would be beneficial to select coil embolization if it could be safe and efficacious in reference to microsurgical clipping. In practice, the main categories of aneurysm involved in daily management would be posterior communicating artery aneurysm, anterior communicating artery aneurysm, middle cerebral artery aneurysm and posterior circulation aneurysm. Anterior communicating artery aneurysm would prefer endovascular embolization with better clinical and cognitive otucome,[9] middle cerebral artery aneurysm would prefer microsurgical clipping due to high recurrence rate and incomplete occlusion rate from endovascular embolization, posterior circulation aneurysm would prefer endovascular embolization due to more demanding skull base approach for many of these aneurysms. Posterior communicating artery aneurysm or posterior communicating segment internal carotid artery aneurysm would be unique in its ease to approach both endovascularly and microsurgically.

One of the potential problems of using 3D-CTA without DSA for treatment selection (endovascular embolization or microsurgical clipping) would be if the 3D-CTA contrast filling was not able to depict the true size and aspect ratio of the aneurysm, some of these aneurysms would be excluded for endovascular embolization in some centers. We thus devised this study to see if these differences existed in patients with ruptured posterior communicating segement internal carotid artery aneurysm, which is an aneurysm approachable also for microscurgical clipping with low morbidity and mortality. We were affirmed that using 3D-CTA alone would be sufficient to make size and geometry assessment for treatment selection.

However, one should still be aware of the potential problem in 3D-CTA examination. It has the same general risks as the other enhanced CT examinations. Contrast agents with iodine must be cautiously used in cases with high risk factors such as renal impairment, congestive heart failure or hypersensitivity to contrast agents. Serious anaphylaxis risk to contrast agents with iodine always exists. One distinct disadvantage is that only the images of a specific phase of circulation may be obtained; in contrast, DSA can demonstrate changes in cerebral vascular flow such as collaterals and cerebral vasospasm.

Magnetic resonance angiography is a potential noninvasive radiological investigation to be considered.[10] It delineates vascular structures without harmful X-rays or iodinated contrast medium. The most important disadvantages of magnetic resonance angiography are long examination time (patient movement), artifacts due to flow phenomenon, applicability to claustrophobic patients and cases requiring life support or monitoring devices.

In conclusion, with modern multislice computed tomography technology, good quality 3D-CTA alone would be sufficient to make size and geometry assessment for treatment selection for patients with ruptured internal carotid artery aneurysm.

References

1. Anderson GB, Steinke DE, Petruk KC, et al. Computed tomographic angiography versus digital subtraction angiography for the diagnosis and early treatment of ruptured intracranial aneurysms. Neurosurgery 1999;45:1315-20.
2. Boet R, Poon WS, Lam JM, Yu SC. The surgical treatment of intracranial aneurysms based on computed tomographic angiography alone-streamlining the management of symptomatic aneurysms. Acta Neurochir (Wien) 2003;145:101-5.
3. Hoh BL, Cheung AC, Rabinov JD, et al. Results of a prospective protocol of computed tomographic angiography in place of catheter angiography as the only diagnostic and pretreatment study for cerebral aneurysms by a combined neurovascular team. Neurosurgery 2004;54:1329-42.
4. Kangasniemi M, Makela T, Koskinen S, et al. Detection of intracranial aneurysms with two-dimensional and three-dimensional helical computed tomographic angiography. Neurosurgery 2004;54:336-40.
5. Tipper G, U-King-Im JM, Price SJ, et al. Detection and evaluation of intracranial aneurysms with 16-row multislice CT angiography. Clin Radiol 2005;60:565-72.
6. Uysal E, Yanbuloglu B, Erturk M, et al. Spiral CT angiography in diagnosis of cerebral aneurysms of cases with acute subarachnoid hemorrhage. Diagn Interv Radiol 2005;11:77-82.
7. Molyneux AJ, Kerr RS, Yu LM, 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.
8. Weir B, Amidei C, Kongable G, et al. The aspect ratio (dome/neck) of ruptured and unruptured aneurysms. J Neurosurg 2003; 99:447-51.
9. Chan A, Ho S, Poon WS. Neuropsychological sequalae of patients treated with microsurgical clipping or endovascular embolization for anterior communicatin artery aneurysm. Eur Neurol 2002; 47:37-44.
10. White PM, Teasdale EM, Wardlaw JM, Easton V. Intracranial aneurysms: CT angiography and MR angiography for detection-Prospective blinded comparison in a large patient cohort. Radiology 2001;219:739-49.