Multislice CT Angiography of Cerebral Aneurysms in Nontraumatic Subarachnoid and Intraparenchymal Haemorrhage

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Abstract

Purpose: The aim of this study was to assess the usefulness of multislice computed tomography angiography (CTA) in identifying and evaluating cerebral aneurysms in patients with nontraumatic subarachnoid and intraparenchymal hemorrhage by comparing it with intraoperative findings.

Material and methods: Between June 2011 and April 2012, fifty patients were included in our study group, they were 38 males and 12 females, their ages ranged from 30 to 60 years (mean 45 years). Each patient in our study with a CT diagnosis of nontraumatic subarachnoid hemorrhage (SAH) underwent CTA. The CTA study was performed with a 64 multidetector device (General electric, lightspeed 64). CTA were evaluated to assess the presence of aneurysms and their morphological characteristics.

Results: We identified 40 aneurysms in the anterior circulation and 10 in the posterior circulation. There were 18 giant aneurysms, 12 large aneurysms, 10 medium aneurysms, 5 small aneurysms and 5 very small aneurysms.

Conclusion: CTA is fast and relatively noninvasive, and it is sensitive in detecting and evaluating intracranial aneurysms. This study confirms the value of CTA as the primary imaging technique in subarachnoid haemorrhage.

Key Words: Multislice CT angiography – Cerebral aneurysm.

Introduction

NONTRAUMATIC subarachnoid haemorrhage (SAH) is a neurological emergency characterized by extravasation of blood into the spaces lining the central nervous system, which are normally filled with CSF. The main cause of nontraumatic SAH (80% of cases) is rupture of an intracranial aneurysm, an event accompanied by high morbidity and mortality rates [1].

The global incidence of SAH, which varies from region to region, is about 10.5 cases per 100,000 inhabitants per year and has remained stable over the last 30 years. The incidence increases with age, with the mean age of presentation being 55 years. Female-to-male ratio is 1.6:1. Mean mortality of patients with SAH is 51%; one third of survivors require life long medical assistance. The main negative prognostic factors include level of consciousness, age and the quantity of blood at initial head computed tomography (CT) scan [2,3].

SAH should always be suspected in patients with the typical presentation of sudden and severe headache associated with nausea, vomiting, neck stiffness, photophobia or loss of consciousness. The physical examination may reveal retinal haemorrhage, evidence of meningeal irritation, reduced level of consciousness and/or focal or unilateral neurological deficit. In the absence of the classic signs and symptoms, SAH can be confused with migraine and tension headaches in 50% of cases [4]. This fact supports the extensive use of CT that, if correctly performed, is capable of identifying an SAH in 100% of cases within 12h of symptom onset and in 93% of cases within 24h [5,6]. Computed tomographic (CT) angiography of the intracranial vessels is now a routine examination that has become fully integrated into the imaging and treatment algorithm for patients with SAH at presentation in many centers in Europe [7] Head CT is also able to identify the presence of intraparenchymal haematomas, hydrocephalus, cerebral oedema and, in some cases, can suggest the probable site of aneurysmal rupture [8]. CTA also has a significant advantage in that it can be performed immediately following the baseline CT examination, which enables a significant shortening of examination times and the possibility of initiating treatment immediately [9].
Patients and Methods

Between June 2011 and April 2012, each patient with a CT diagnosis of nontraumatic SAH underwent CTA. We enrolled 50 consecutive patients (38 males and 12 females) with a mean age of 45 years (range 30-60). No patient preparation was required as most of the patients were in emergency and the region of interest needed no specific preparation. The CTA study was performed with a 64 multidetector device (General electric, lightspeed 64) with the following acquisition and reconstruction parameters: scan in the axial plane extending from the body of the first cervical vertebra to the vertex, collimation 0.75mm, gantry rotation time 0.5s, field of view (FOV) 230mm, feed/rotation 6.5, 120kV, 210mAs, real-time reconstruction 3mm/3 mm with FOV 120, postprocessing reconstruction 1mm/0.5mm with FOV 80. Contrast enhancement was provided by the intravenous antecubital administration of an 80ml bolus of nonionic iodinated contrast material at a 4-ml/s flow rate followed by 50ml saline solution at the same rate. The contrast material was administered with an automatic injector. Synchronisation between the scan and contrast material passage was obtained in real time with the bolus tracking technique. The sample volume was positioned in an internal carotid artery with a threshold of +30 HU.

After acquisition data transfer to the post processing station, image analysis was performed interactively post processing techniques, including two- (2D) and three-dimensional (3D) multiplanar reconstructions (MPR), maximum intensity projections (MIP) and volume rendering (VR). CTA examination was assessed and the aneurysms were classified according to the following scheme:

Site:
- **Aneurysms originating from the anterior circulation:** Internal carotid artery, ophthalmic artery, anterio choroidal artery, anterior communicating artery, anterior cerebral artery, pericallosal artery, callosal marginal artery, middle cerebral artery, posterior communicating artery.
- **Aneurysms originating from the posterior circulation:** Basilar artery, apex of the basilar artery, postterior cerebellar artery, anteroinferior cerebellar artery, anteroinferior cerebellar artery, anteriosuperior cerebellar artery, posterior cerebral artery.

Size:
- Giant aneurysms: ≥25mm.
- Large aneurysms: 13-24mm.
- Medium aneurysms: 5-12mm.
- Small aneurysms: 3-4mm.
- Very small aneurysms: <3mm.

Neck:
- Aneurysm with a narrow neck: Diameter neck/diameter sac <1/3.
- Aneurysm with a wide neck: Diameter neck/diameter sac ≥1/3.

Results

Fifty patients were included in the study group, they were 38 males and 12 females, their ages ranged from 30 to 60 years (mean 45 years).

Variable symptoms were seen in our cases including headache (90% of patients), neck stiffness (80% of patients), vomiting (75% of patients), seizures (30% of patients), confusion (25% of patients) and coma (10% of patients).

According to site of the aneurysm in our study (Table 1), we identified 40 aneurysms in the anterior circulation and 10 in the posterior circulation. Among the 40 aneurysms seen at the anterior circulation there were 18 at anterior communicating artery, 8 at anterior cerebral arteries (6 at right and 2 at left), 6 at posterior communicating arteries (4 at right and 2 at left), 4 at internal carotid arteries (2 at right and 2 at left) and 4 at middle cerebral arteries (3 at right and 1 at left). Among the 10 aneurysms seen at the posterior circulation there were 4 at apex of the basilar artery, 3 at the basilar artery and 3 at posterior cerebral arteries (1 at right and 2 at left).

According to the size of the aneurysm in our study (Table 2), there were 18 giant aneurysms, 12 large aneurysms, 10 medium aneurysms, 5 small aneurysms and 5 very small aneurysms.

According to the neck of the aneurysm (Table 3) there were 25 aneurysms with narrow neck and 25 aneurysms with wide neck.

<table>
<thead>
<tr>
<th>Site</th>
<th>Incidence</th>
</tr>
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<tbody>
<tr>
<td>Anterior communicating artery</td>
<td>18 (36%)</td>
</tr>
<tr>
<td>Anterior cerebral artery</td>
<td>8 (16%)</td>
</tr>
<tr>
<td>Posterior communicating artery</td>
<td>6 (12%)</td>
</tr>
<tr>
<td>Internal carotid artery</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>Basilar artery</td>
<td>7 (14%)</td>
</tr>
<tr>
<td>Posterior cerebral artery</td>
<td>3 (6%)</td>
</tr>
</tbody>
</table>
Table (2): Size of the aneurysms.

<table>
<thead>
<tr>
<th>Size</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Giant</td>
<td>18 (36%)</td>
</tr>
<tr>
<td>Large</td>
<td>12 (24%)</td>
</tr>
<tr>
<td>Medium</td>
<td>10 (20%)</td>
</tr>
<tr>
<td>Small</td>
<td>5 (10%)</td>
</tr>
<tr>
<td>Very small</td>
<td>5 (10%)</td>
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Table (3): Neck of the aneurysms.

<table>
<thead>
<tr>
<th>Size</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Wide</td>
<td>25 (50%)</td>
</tr>
<tr>
<td>Narrow</td>
<td>25 (50%)</td>
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Presence of SAH (Fig. 1-A) alone was detected in 40 patients, and with intraparenchymal hemorrhage in 10 patients.

Arterial spasm (Fig. 1-B,C) was detected in 10 cases (6 showed spasm of anterior cerebral artery and 4 shows spasm of posterior cerebral artery).

Thrombosis (Fig. 2-B) of large aneurysms was also detected in 3 cases. No thrombosis could be detected at other aneurysms.

All CTA examinations were technically assessable. All patients who presented for the CTA examination without assisted ventilation were studied without sedation. All CTA procedures were without complications (allergic reactions, acute renal failure or extravasation at the site of venous injection).

In comparison with operative findings, there was only one false negative and no false positives. Therefore, sensitivity and specificity reached 98% and 100%, respectively, with a positive predictive value of 100%, negative predictive value of 98% and diagnostic accuracy of 98%.

There was excellent agreement between the CTA and intraoperative findings with regard to size, morphology and angioarchitect.

Fig. (1): A 60 years female patient with subarachnoid and left frontal hemorrhage (A) axial CT examination shows the hemorrhage, (B) MIP shows a very small aneurysm in the anterior communicating artery and arterial spasm of left anterior cerebral artery, (C) VR shows the same finding (the white arrow refers to the aneurysm).
Fig. (2): A 49 years male patient presented with subarachnoid hemorrhage (A) non contrast axial CT examination shows a large basilar artery aneurysm, (B) Contrast enhanced CT shows partial thrombosis of the aneurysm, (C) MIP, (D) VR of the same case.

Fig. (3): A 40 years male patient with subarachnoid hemorrhage (A) axial CT examination shows the hemorrhage and medium sized aneurysm of the anterior communicating artery (black arrow), (B) VR shows the aneurysm (the white arrow refers to the aneurysm).
Discussion

Patients in our study with SAH are generally in poor clinical condition that included strong headaches, seizures, confusion, and even coma and this clinical condition was reported in many series [7,10,11]. Such condition was suitable for CTA in our study especially it is a non invasive technique and in contrary to a study showed that DSA which was the reference method for SAH diagnostic evaluation, but it is invasive, time consuming, and, thus, more difficult to perform in patients with such a condition [10]. This comparison is going with a series revealed that noninvasive techniques, such as CTA, have been developed and are increasingly recognized as alternatives to DSA. However, these techniques must have a diagnostic sensitivity and specificity close to DSA if they have to be used as first-intention diagnostic methods in the future [11].

The 64 multidetector CT device used in our study have led to improved spatial-temporal resolution, thus enabling an accurate and minimally invasive study of cerebral aneurysms, even in the event of acute SAH. Shorter acquisition times and increased spatial resolution are two important advantages introduced by 64-slice scanners. The possibility of performing CTA immediately following a CT diagnosis of SAH, along with the noninvasiveness of the technique, speed of execution and high diagnostic sensitivity and specificity, these data was reported also by other examiners [12].

Our study involving 50 patients, in all cases, CTA was technically feasible and was well tolerated by all patients. All examinations could be assessed, and there were no major motion artefacts. Sedation was not required for any of the CTA studies in our series. A CTA examination is performed in about 10 min, to which are added the average time required for image postprocessing and interpretation of about 15-20min. The findings are therefore available 25-30 minutes after the patient arrives at the CT station, these data is going with by a study done in 2007 [13]. In comparison with a study with a cerebral DSA, it revealed that DSA required angiographic experience, and when performed by an expert has a duration of 45-60min, to which is added about 10 min for reporting the findings [14].

In agreement with the literature [15-17], we would like to emphasise the absolute need to assess the CTA findings at the postprocessing workstation, the study must not fail to include 2D (MPR and MIP) and volumetric (VR) reconstructions. MPR, which were assessed in cine mode in the three orthogonal planes in space, help confirm the presence of the aneurysm or determine whether it was not identified in the axial plane alone. MIP project only the most luminous voxels of the selected volume in the reconstruction plane; these are 2D reconstructions with the loss of spatial information. VR is a 3D reconstruction technique that requires definition of a threshold attenuation value (measured in Hounsfield units) for selecting reconstruction voxels.

In comparison with a study done in 2011 [7] revealed that CT angiography had a relatively high false-negative rate in the detection of small aneurysms near the central skull base because of the presence of overlying bone structures and the complex vascular anatomy, in our study, there was only one false negative at CTA, which in fact was in regard to a very small aneurysm (2mm). This was one of the first cases in the study, a time when our experience with the technique was still limited. During the study, we noted how our increasing technical confidence rendered recognition of even very small aneurysms relatively easy.

We have shown that CTA has high sensitivity and specificity to detect intracranial aneurysms. Our results are going with multiple series, concerning CTA with multidetector row scanner, reported sensitivity between 95.1% and 98% and specificity of 100% for the detection of intracranial aneurysms [18-20].

Conclusion:

CTA is fast and relatively noninvasive, and it is sensitive in detecting and evaluating intracranial aneurysms. This study confirms the value of CTA as the primary imaging technique in subarachnoid haemorrhage.

References


