Rebleeding from Cerebral Aneurysms during 3DCT Angiography

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Abstract

Background and purpose: Computed Tomographic Angiography (CTA) is commonly used for the non-invasive detection of cerebrovascular lesions responsible for subarachnoid hemorrhage, but rebleeding may occur during this procedure. We investigated imaging findings and related factors in patients who experienced rebleeding during CTA in our hospital.

Materials and methods: Participants comprised 112 patients who underwent CTA for ruptured cerebral aneurysm in our hospital between January 10 and December 2015 [1]. CTA was performed using a 64-row detector system.

Results: Rebleeding occurred during CTA in 5 of 112 patients, representing a rebleeding rate of 4.5%. Mean time from initial onset of hemorrhage to CTA was shorter in patients with rebleeding (median, 228 min; P=0.051), and blood pressure at the time of initial treatment tended to be higher for patients with rebleeding. Patients with rebleeding showed either: a) spiral or wave-shaped hemorrhage into the cistern in which the aneurysm was located; or b) tear-drop-shaped hemorrhage within the hematoma. Patients with rebleeding were all grades 5 according to the World Federation of Neurological Surgeons (WFNS) and underwent CTA within 3 h of onset.

Conclusion: CTA offers excellent performance for the diagnosis of cerebral aneurysm, but the use of intravenous contrast agent may carry some risk of rebleeding. History of recent severe subarachnoid hemorrhage also appears to represent a risk factor for rebleeding. As contrast agent injection may produce hemodynamic effects, management of fluctuations in blood pressure during CTA is crucial.

Keywords: Subarachnoid hemorrhage; Aneurysm; CT; CTA; Rebleeding; Intracerebral hemorrhage; Ruptured aneurysm

Introduction

Computed Tomographic Angiography (CTA) is a non-invasive test with high diagnostic performance that enables the detection of cerebrovascular lesions responsible for subarachnoid hemorrhage and is relatively simple compared with angiography, provided the patient has no restrictions regarding the use of contrast agent [2-4]. Although CTA is widely used, we have encountered cases in which rebleeding occurred from ruptured cerebral aneurysms during CTA. Numerous reports have described the risk of rebleeding from ruptured cerebral aneurysms during angiography if angiography is performed within the first 6 h after rupture, and prognosis after rebleeding is poor [5-8]. Although many studies have discussed the value of CTA, few reports have described rebleeding from ruptured cerebral aneurysms during CTA. We report herein an investigation of imaging findings and related factors in patients who experienced rebleeding during CTA, together with a discussion of the literature.

Experimental

Subjects comprised 112 patients who underwent CTA for ruptured cerebral aneurysm in our hospital between January 2010 and December 2015. Cranial Computed Tomography (CT) was carried out after the conclusion of initial treatment, and CTA was performed after subarachnoid hemorrhage had been confirmed and blood pressure control implemented with antihypertensive agents. CTA was carried out using a Toshiba Aquilion 64-row detector system, with imaging conditions according to the standard protocol below. Image processing of the source images acquired was performed using a workstation (Zio M900 workstation, Amin Co., Tokyo, Japan), on which CTA images and multiplanar reconstruction (MPR) images were produced. Patients for whom the use of contrast agent was contraindicated for reasons such as kidney dysfunction or history of allergy to contrast agents were excluded from this study.

Results

Rebleeding during CTA occurred in 5 of 112 patients with subarachnoid hemorrhage due to ruptured cerebral aneurysm, representing a rebleeding rate of 4.5%. Table 1 shows the clinical attributes of patients with and without rebleeding. Mean time from onset to CTA was shorter in patients with rebleeding (median, 88 min) than in patients without rebleeding (median, 228 min; P=0.051), and blood pressure at the time of initial treatment tended to be higher for patients with rebleeding.

Two patterns of imaging findings were observed in patients with rebleeding. These comprised spiral or wave-shaped hemorrhage into the cisterna in which the aneurysm was located, or a tear-drop-shaped hemorrhage within the hematoma.

Although no significant differences were seen between patients with and without rebleeding in terms of clinical attributes such as sex, age, or blood pressure at an initial correspondence patients with rebleeding were all grade 5 according to the World Federation of Neurological Surgeons (WFNS) and underwent CTA within 3 h of onset.
Rebleeding Cases

The cases of rebleeding encountered at our hospital between January 2010 and December 2015 are described below. Table 2 shows rebleeding patients in our series were summarized.

Case 1 (Figure 1)

A 54-yr-old woman presented with onset marked by sudden impairment of consciousness (grade 5). Cranial CT showed a thick subarachnoid hemorrhage in the right Sylvian fissure, and CTA revealed aneurysm of the right Middle Cerebral Artery (MCA). Contrast agent was observed leaking from the aneurysm into the cistern. Craniotomy and clipping of the ruptured aneurysm and hematomectomy of the intracerebral hematoma were performed on Day 0, but no improvement in consciousness was obtained, and Glasgow Outcome Scale (GOS) score after 1 month was Vegetative State (VS).

Case 2 (Figure 2)

A 39-yr-old woman presented with onset marked by sudden impairment of consciousness (grade 5). Cranial CT showed subarachnoid hemorrhage centered on the basal cistern. CTA revealed an aneurysm at the branching point of the internal carotid artery (ICA) and the anterior choroid artery, with contrast agent leaking in a spiral shape from the tip of the aneurysm into the basal cistern. Coil embolization of the ruptured aneurysm was performed on Day 0. GOS score after 1 month was moderate disability (MD).

Case 3 (Figure 3)

A 53-yr-old woman presented with onset marked by seizure (grade 5). Cranial CT showed subarachnoid hemorrhage, mainly in the basal cistern. CTA revealed aneurysm of the left anterior cerebral artery. Contrast agent was pooled in the basal cistern. After rebleeding, the patient showed a sudden drop in blood pressure, and died on Day 16 without having undergone curative surgery for the source of hemorrhage.

Case 4 (Figure 4)

A 63-yr-old man presented with onset marked by sudden impairment of consciousness (grade 5). Cranial CT showed intracerebral and subarachnoid hemorrhage, mainly in the left Sylvian fissure and temporal lobe. CTA revealed an aneurysm of the left middle cerebral artery, with contrast agent leaking into the intracerebral hematoma. Craniotomy and clipping of the ruptured aneurysm and hematomectomy of the intracerebral hematoma were performed on Day 0, but the intracerebral hematoma enlarged and worsened and the patient died from concomitant heart failure on Day 2.

| Gender | No Rebleeding | Rebleeding | All | P |
|--------|---------------|------------|-----|---|
| Male   | 35            | 1          | 36  | 0.551 |
| Female | 72            | 4          | 76  |     |

| Aneurysm site | No Rebleeding | Rebleeding | All | P |
|---------------|---------------|------------|-----|---|
| ACA           | 31            | 2          | 33  | 0.468 |
| MCA           | 24            | 2          | 26  |     |
| PcomA         | 28            | 0          | 28  |     |
| ICA           | 9             | 1          | 10  |     |
| Posterior circulation | 15 | 0 | 15 |     |

| Aneurysm size | No Rebleeding | Rebleeding | All | P |
|---------------|---------------|------------|-----|---|
| <7mm          | 75            | 4          | 79  | 0.634 |
| ≥ 7mm         | 32            | 1          | 33  |     |
| 1             | 15            | 0          | 15  |     |
| 2             | 35            | 0          | 35  |     |
| 3             | 24            | 0          | 24  |     |
| 4             | 19            | 0          | 19  |     |
| 5             | 14            | 5          | 19  |     |
|                |               |            |     |     |
| WFNS scale    |               |            |     | <0.001 |
| 1             | 11            | 0          | 11  |     |
| 2             | 30            | 0          | 30  |     |
| 3             | 55            | 4          | 59  |     |
| 4             | 11            | 1          | 12  |     |

| Fisher grade | No Rebleeding | Rebleeding | All | P |
|--------------|---------------|------------|-----|---|
| 1            | 11            | 0          | 11  | 0.379 |
| 2            | 5            | 0          | 5   |     |
| 3            | 55            | 4          | 59  |     |
| 4            | 11            | 1          | 12  |     |

| Interval time between initial bleeding and CTA (min) | No Rebleeding | Rebleeding | All | P |
|-----------------------------------------------------|---------------|------------|-----|---|
| -                                                   | 228 (30-1440) | 88 ± 53.5 (50-180) | 218 (30-1440) |     |

ACA: Anterior Cerebral Artery; MCA; Middle Cerebral Artery; PcomA: Posterior Communicating Artery; ICA: Internal Carotid Artery; WFNS: World Federation of Neurological Surgeon Scale

Table 1: Clinical data of patients with aneurysmal SAH.

| Case | Age (Year/Sex) | Rebleeding interval (min) | Aneurysm site | Size (mm) | WFNS grade | Fisher group | Therapy | GOS |
|------|----------------|---------------------------|---------------|-----------|------------|--------------|---------|-----|
| 1    | 54/F           | 180                       | MCA           | 2         | 5          | 3            | Clip    | 2   |
| 2    | 39/F           | 60                        | ICA           | 2         | 5          | 3            | Coll    | 4   |
| 3    | 58/F           | 90                        | ACA           | 5         | 5          | 3            | (-)     | 1   |
| 4    | 63/M           | 50                        | MCA           | 10        | 5          | 4            | Clip    | 1   |
| 5    | 66/M           | 60                        | ACA           | 3         | 5          | 3            | Coll    | 1   |

ACA: Anterior Cerebral Artery; MCA; Middle Cerebral Artery; PcomA: Posterior Communicating Artery; ICA: Internal Carotid Artery; WFNS: World Federation of Neurological Surgeon Scale

Table 2: Clinical data of rebleeding patients with aneurysmal SAH.
Discussion

To establish treatment strategies in cases of subarachnoid hemorrhage due to ruptured cerebral aneurysm, detailed investigation of the source of hemorrhage and consideration of options to prevent rebleeding are required. Cerebral Angiography, Cranial Magnetic Resonance Angiography (MRA), and CTA are all diagnostic procedures that can be used for this purpose.
Although cranial angiography is a vital test with high diagnostic performance for the diagnosis of cerebral aneurysm, performance of this test within 6 h of the onset of subarachnoid hemorrhage increases the risk of rebleeding, with a reported frequency of 3.3% to 4.8% [5,6,8]. Rebleeding is particularly common in patients at severe grades or with aneurysms of the ICA or MCA [5-8].

Cranial MRA offers inferior diagnostic performance to CTA with respect to the detection of cerebral aneurysm on some points [9,10] but is regarded as a valuable screening method. As MRA also provides less surgical information compared with CTA and the diagnostic concordance rate between different doctors is poor compared with angiography, the technique is most often only used as a supplementary method of diagnosis [11].
CTA offers excellent performance for the diagnosis of cerebral aneurysm, and numerous reports have described its value [6,12]. The capacity of CTA for the detection of cerebral aneurysm is reportedly equivalent to that of angiography, and this modality provides more information for performing surgical procedures, and can be performed non-invasively within a short period of time, making it useful for the diagnosis of cerebral aneurysm [13,14].

Nakatsuka et al. performed CTA on 28 patients with subarachnoid hemorrhage and reported a rebleeding rate of 17.9% [15], while Hashiguchi et al. reported rebleeding in 2 of 61 patients (3.3%) [16]. As rebleeding also occurred in 4 patients (6.7%) in our own series, occurrence during CTA is far from infrequent.

The rate of rebleeding in our hospital in the present study was almost the same as that reported elsewhere, and one characteristic of all the patients with rebleeding was the previous presence of grade 5 subarachnoid hemorrhage. Table 2 shows a summary of reported cases [16-21]. Rebleeding was more common in patients with severe subarachnoid hemorrhage and tended to be more frequent in those who underwent CTA within 3 h of initial bleeding, but no consistent findings were seen with respect to aneurysm location. Outcomes were poor for patients who experienced rebleeding. In addition to the performance of testing, other factors indicating a high risk of rebleeding include early period after onset, with many cases reported 2 h after onset [22] and as short duration after onset has been reported as an independent risk factor for rebleeding [11] the risk entailed in the early performance of this test after onset must be kept in mind, and efforts must be made to adjust the timing of this test in accordance with circumstances.

To determine a treatment policy for ruptured cerebral aneurysm with intracerebral hemorrhage, however, some cases require identification of the source of hemorrhage at an early stage and consideration of surgical procedures to prevent rebleeding, so whether CTA should be performed must be considered according to the individual situation of the patient.

In imaging findings from CTA in cases of rebleeding, contrast agent was visualized in a spiral shape in some cases and as a tear-drop-shaped mass in others. This difference was due to the location of rebleeding in the aneurysm, and whether the contrast agent was diluted by cerebrospinal fluid was also a contributing factor [19]. Rebleeding into a cerebral cistern, as in Cases 1 and 2, was visualized as a spiral shape on CTA, whereas rebleeding into a hematoma cavity, as in Cases 3, 4 and 5, appeared as a mass (daughter aneurysm). Because these findings are easily identified as signs of contrast agent leakage on the CTA source image, whether rebleeding has occurred must be confirmed immediately after CTA scanning. Presence or absence of rebleeding should be ascertained on the source image during CTA for severe-grade patients and patients in the early phase of subarachnoid hemorrhage in particular.

Many points regarding the mechanisms of onset for rebleeding during CTA remain unclear. During angiography, arterial injection of contrast medium may cause a localized rise in blood pressure, which has been reported as contributing to rebleeding [21]. CTA utilizes intravenous injection, which does not contribute to a transient rise in blood pressure, and is therefore believed to not increase the risk of rebleeding [15,21,7]. As contrast agent is used intravenously during the performance of CTA, however, the possibility of some involvement in rebleeding cannot be ruled out. Contrast agent injection reportedly produces hemodynamic effects, resulting in a temporary rise in systemic blood pressure [23-25] and fluctuations in blood pressure during CTA may contribute to rebleeding. Management of fluctuations in blood pressure during the performance of CTA is therefore crucial.

**Conclusion**

We investigated cases of rebleeding from ruptured cerebral aneurysms during the performance of CTA at our hospital. Although CTA is an extremely useful examination when considering treatment for ruptured cerebral aneurysm, rebleeding can occur during scanning in some patients and care is therefore required.
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