Pure subdural haematoma caused by rupture of middle cerebral artery aneurysm: Case report and literature review

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Abstract
Pure subdural haematoma (occurring without detectable subarachnoid haemorrhage) caused by intracranial aneurysm rupture is uncommon and is usually associated with delayed diagnosis and treatment. We describe the case of a 43-year-old man who presented with ongoing headache. Computed tomography and magnetic resonance imaging of the brain revealed subdural haematoma in the left fronto–temporo–parietal region, without subarachnoid haemorrhage. Digital subtraction angiography showed an aneurysm measuring ≤5 mm in diameter, arising from the distal region of the left middle cerebral artery. During hospitalization, an acute change in mental status accompanied by slurred speech and narcolepsy prompted an emergency CT scan. This revealed an enlargement of the subdural haematoma. The patient underwent an emergency craniotomy, during which a large amount of bloody fluid was evacuated, and the aneurysm was coagulated and resected. The patient had a good outcome without neurological deficit. The incidence, mechanisms and treatment of this condition are discussed.

Keywords
Subdural haematoma, intracranial aneurysm, middle cerebral artery

Introduction
Aneurysms of the middle cerebral artery (MCA) comprise 20–30% of all intracranial aneurysms. Intracranial aneurysm rupture is classically characterized by subarachnoid haemorrhage and intracerebral haematoma. Pure subdural haematoma (occurring without detectable subarachnoid haemorrhage) caused by intracranial...
aneurysm rupture is uncommon.\textsuperscript{3,4} We report a case of pure subdural haematoma secondary to MCA aneurysm rupture.

Case report

A 43-year-old man presented at the Department of Neurosurgery, Zhejiang Hospital, Hangzhou China on 13 August 2010 with a history of headache for 8 days. He reported no loss of consciousness, nausea, vomiting, dizziness or neurological deficit. The patient had no explicit history of head trauma, hypertension or coagulopathy. Emergency computed tomography (CT) and magnetic resonance imaging of the head revealed subdural haematoma in the left fronto–temporo–parietal region without subarachnoid haemorrhage or intracerebral haematoma (Figure 1A–C). No aneurysm or arteriovenous malformation was detected on CT angiography. As the haematoma

![Brain images from a 43-year-old man presenting with a history of headache for 8 days. (A) Axial noncontrast computed topography (CT) scan showing a lunar hyperdense lesion in the left fronto–temporo–parietal region with no evidence of subarachnoid haemorrhage (white arrow); (B) T1-weighted magnetic resonance image (MRI) revealing the haematoma as high intensity with isointense components (white arrow); (C) T2-weighted MRI revealing the haematoma as low intensity with high intensity components (white arrow); (D) Angiogram of the left middle cerebral artery (MCA) revealing a small aneurysm located in the distal region of the MCA (black arrow); (E) Axial noncontrast CT scan showing mixed-density haematoma in the left fronto–temporo–parietal region with midline shift (white arrows); (F) Intraoperative view, confirming a small MCA aneurysm embedded in the subdural haematoma (black arrow). The colour version of this figure is available at: http://imr.sagepub.com.](image-url)
showed no signs of enlargement, emergency craniotomy was not recommended at initial presentation but the patient was admitted to hospital.

Digital subtraction angiography performed 6 days after hospitalization showed normal appearance of the right internal carotid artery (ICA), MCA and anterior cerebral artery (ACA). An aneurysm measuring <5 mm in diameter was seen arising from the left distal region of the MCA, and was accompanied by an occluded left A1 segment of the ACA. The dome of the aneurysm was oriented towards the subdural space. No vasospasm was present (Figure 1D). Due to the small size of the aneurysm and lack of any accompanying subarachnoid haemorrhage, it was unclear whether the aneurysm was the underlying cause of the subdural haematoma and craniotomy was therefore not pursued at that time.

However, 8 days after hospitalization, the patient developed an acute change in mental status accompanied by slurred speech and narcolepsy, prompting an emergency CT scan. Enlargement of the left-sided subacute subdural haematoma was revealed as a mixed-density subdural lesion, indicating subacute haemorrhage, and was accompanied by a new slight midline shift (Figure 1E). The patient underwent an emergency craniotomy, during which an MCA aneurysm was seen: this was embedded within the subacute subdural haematoma, with the dome of the aneurysm fused to the thick parietal layer of the subdural haematoma capsule (Figure 1F). A large amount of bloody fluid was evacuated, the site was irrigated with normal saline, and the aneurysm was coagulated and resected. No evidence of subarachnoid blood was seen intraoperatively.

Histopathology of the resected tissue revealed the formation of a fibrous wall around the aneurysm. The patient had an unremarkable postoperative course, without neurological deficit or subjective discomfort. The patient was discharged from hospital 14 days postoperatively.

**Discussion**

Intracranial aneurysms usually present as subarachnoid haemorrhages or intracerebral haematomas, with only 0.5–7.9% being accompanied by subdural haematomas.5–9 Pure subdural haematoma caused by intracranial aneurysm is extremely rare.5,10 We describe a case of ruptured MCA aneurysm presenting as pure subdural haematoma, without radiographic evidence of subarachnoid haemorrhage or intracerebral haematoma at any point during hospitalization. An additional 40 similar cases of pure subdural haematoma caused by intracranial aneurysm have been reported since 1980 (Table 1).3–8,10–35 The average age at presentation was 46.6 years, with 27/41 patients (65.9%) being female. The site of aneurysm included ICA-posterior communicating artery (PcomA; 16 cases, 39.0%), MCA (10 cases, 24.4%; including the present case), anterior communicating artery (AcomA; six cases, 14.6%), distal ACA (four cases, 9.8%) and other sites (five cases, 12.2%). Subdural haematoma may be located in the cerebral convexity (24 cases, 58.5%; including the present case), both convexity and tentorium (seven cases, 17.1%) and other locations (nine cases, 22.0%). The most common treatment was haematoma evacuation and clipping (19 cases, 46.3%). Haematoma evacuation and aneurysm resection was used in two cases (4.9%; including the present case). The majority of patients had a good outcome (25 cases, 61.0%; including the present case).

Several mechanisms have been proposed to explain pure subdural haematoma caused by intracranial aneurysm: (i) minor haemorrhages may cause adhesion of the aneurysm to the arachnoid membrane with a final
| Author(s) | Year of publication | Age | Sex | Symptoms/signs | Location of aneurysm | Location of subdural hematoma | Treatment | Outcome |
|-----------|---------------------|-----|-----|----------------|----------------------|-------------------------------|-----------|---------|
| Rengachary and Szymanski | 1981 | 49 | M | Confusion, dysphagia | MCA | Convexity | Haematoma evacuation and clipping | Good |
| Eggers et al | 1982 | 34 | F | Headache | ICA-PcomA | Convexity | Haematoma evacuation | Good |
| Williams et al | 1983 | 18 | F | Coma | ICA-PcomA | Convexity | Haematoma evacuation and clipping | Disabled |
| Friedman and Brandt-Zawadzki | 1983 | 55 | F | Headache | ICA-PcomA | Tentorium and interhemispheric | Clipping | Good |
| O’Leary and Sweeny | 1986 | 28 | F | Coma | MCA | Convexity | None | Death |
| Kondziolkla et al | 1988 | 43 | M | Coma | ICA-PcomA | Tentorium and convexity | Haematoma evacuation and clipping | Good |
| Kondziolkla et al | 1988 | 38 | F | Coma | ICA-PcomA | Tentorium and convexity | Haematoma evacuation and clipping | Disabled |
| Shinmura et al | 1989 | 53 | F | Coma | MCA | Convexity | Haematoma evacuation and clipping | Disabled |
| Onda et al | 1989 | 44 | F | Semicoma | ICA-PcomA | Convexity | Haematoma evacuation and clipping | Disabled |
| Watanabe et al | 1991 | 51 | M | Semicoma | Distal ACA | Interhemispheric and convexity | Haematoma evacuation and clipping | Death |
| Ragland et al | 1993 | 27 | M | Coma | AcomA | Convexity | Haematoma evacuation | Death |
| Hatayama et al | 1994 | 55 | M | Semicoma | Distal ACA | Interhemispheric and convexity | Haematoma evacuation and clipping | Good |
| Hatayama et al | 1994 | 66 | F | Semicoma | Distal ACA | Interhemispheric, convexity, and tentorium | Haematoma evacuation and clipping | Disabled |
| Ishibashi et al | 1997 | 54 | F | Headache | ICA-PcomA | Tentorium and convexity | Haematoma evacuation and clipping | Good |
| Satoh et al | 1999 | 58 | F | Semicoma | ICA-PcomA | Convexity | | Good |
Table 1. Continued.

| Author(s)       | Year of publication | Age | Sex | Symptoms/signs       | Location of aneurysm | Location of subdural hematoma | Treatment                                | Outcome |
|-----------------|---------------------|-----|-----|----------------------|----------------------|------------------------------|------------------------------------------|---------|
| Satoh et al     | 1999 22 F Headache  | 25  | F   | ICAPcomA              | Convexity            | Haematoma evacuation and clipping | Good                                    |         |
| Satoh et al     | 1999 22 F Coma       | 22  | F   | ICAPcomA              | Convexity            | Haematoma evacuation and clipping | Good                                    |         |
| Huang et al     | 1999 61 F Headache   | 61  | F   | MCA                  | Tentorium and convexity | Haematoma evacuation and clipping | Good                                    |         |
| Nonaka et al    | 2000 52 F Coma       | 52  | F   | ICAPcomA              | Tentorium and convexity | Haematoma evacuation and clipping | Good                                    |         |
| Ishikawa et al  | 2000 62 M Headache, ptosis | 62  | M   | ICAPcomA              | Tentorium and interhemispheric | Clipping                      | Good                                    |         |
| Inamasu et al   | 2002 28 F Coma       | 28  | F   | ICAPcomA              | Convexity            | Haematoma evacuation and clipping | Death                                   |         |
| Araki et al     | 2002 55 F Headache, ptosis, semicoma | 55  | F   | ICAPcomA              | Convexity            | Haematoma evacuation and clipping | Good                                    |         |
| Nozar et al     | 2002 56 M Headache, drowsiness | 56  | M   | AcomA                 | Convexity            | Haematoma evacuation and clipping | Death                                   |         |
| Nozar et al     | 2002 28 M Headache   | 28  | M   | PcomA                 | Convexity            | Haematoma evacuation and clipping | Good                                    |         |
| Nozar et al     | 2002 39 F Headache   | 39  | F   | PcomA                 | Convexity            | Coiling                      | Good                                    |         |
| Nozar et al     | 2002 46 M Coma       | 46  | M   | MCA                  | Convexity            | Haematoma evacuation and clipping | Death                                   |         |
| Blake et al     | 2003 35 F Coma       | 35  | F   | ICAPcomA              | Convexity            | None                         | Death                                   |         |
| Katsuno et al   | 2003 63 F Headache, nausea, dizziness | 63  | F   | Distal ACA            | Interhemispheric and convexity | Haematoma evacuation and clipping | Good                                    |         |
| Krishnaney et al| 2004 42 F Headache, photophobia | 42  | F   | AcomA                 | Tentorium and convexity | Haematoma evacuation and clipping | Good                                    |         |
| Koerbel et al   | 2005 62 F Bifurcation of ICA | 62  | F   | Convexity            | Convexity            | Haematoma evacuation and clipping | Good                                    |         |
| Author(s)          | Year of publication | Age | Sex | Symptoms/signs | Location of subdural hematoma | Location of aneurysm | Treatment | Outcome       |
|--------------------|---------------------|-----|-----|----------------|-------------------------------|---------------------|-----------|---------------|
| Triantafyllou et al | 2006                | 65  | F   | Headache, semi-coma | ICA                           | Convexity and cavernous sinus | Haematoma evacuation and coiling | Comatose     |
| Glad et al         | 2007                | 47  | M   | Nausea, vomiting, ptosis | AcomA                         | Sella, migrating to spinal sinus | Coiling | Good          |
| Kocak et al        | 2009                | 47  | F   | Not described | AcomA                         | Not described | Haematoma evacuation and resection | Good          |
| Kurabe et al       | 2010                | 75  | M   | Headache, vomiting | MCA                           | Anterior fossa | Clipping | Good          |
| Field and Heran    | 2010                | 33  | M   | Not described | MCA                           | Convexity | Haematoma evacuation and coiling | Good          |
| Weil et al         | 2010                | 51  | F   | Headache | MCA                           | Convexity | Haematoma evacuation and coiling | Good          |
| De Blasi et al     | 2010                | 47  | M   | Headache, Terson syndrome | MCA                           | MCA-PcomA | Coiling | Good          |
| De Blasi et al     | 2010                | 60  | F   | Headache, stupor, abducens | MCA                           | Convexity | Haematoma evacuation and coiling | Good          |
| Takada et al       | 2012                | 54  | M   | Headache | MCA                           | Convexity | Haematoma evacuation and coiling | Good          |
| Miki et al         | 2012                | 40  | F   | Nausea, vomiting | MCA                           | Convexity | Haematoma evacuation and coiling | Good          |
| Present case       | 2014                | 43  | M   | Headache | MCA                           | Convexity | Haematoma evacuation and resection | Good          |

MCA, middle cerebral artery; ICA, internal carotid artery; PcomA, posterior communicating artery; ACA, anterior cerebral artery; AcomA, anterior communicating artery.
bleed occurring into the subdural space,\textsuperscript{10,24,25,31} (ii) high-pressure haemorrhage from the ruptured aneurysm may lacerate the arachnoid membrane;\textsuperscript{25,26,31,32} (iii) intracerebral bleeding may rupture the cortex and tear the arachnoid membrane;\textsuperscript{21,26} (iv) enlargement of the intracavernous aneurysm could erode the wall of the cavernous sinus;\textsuperscript{5,32} (v) a carotid artery aneurysm located in the subdural space may cause subdural haematoma directly.\textsuperscript{21,36,37}

Clinical and radiographical findings in the present case indicate that the patient experienced two discrete episodes of aneurysm rupture. The first manifested as headache, indicating that blood from the aneurysm had penetrated the arachnoid membrane into the subdural cavity. The second rupture, which occurred 16 days after the first, manifested as narcolepsy and slurred speech, implying enlargement of the subarachnoid haemorrhage. The tight adhesions that were observed intraoperatively strongly support the first mechanism described above.

In conclusion, pure subdural haematoma can be caused by rupture of intracranial aneurysm. The rarity of this condition can lead to delays in diagnosis and treatment, as occurred in the present case.\textsuperscript{4,7,26,30,31} In addition, the mild symptoms (which may occur several days before admission) are unusual for aneurysm rupture, and intracranial aneurysm bleeding is often ruled out in the absence of subarachnoid haemorrhage. Aneurysm rupture should be strongly considered, however, if a patient presents with a pure subdural haematoma without history of trauma or coagulopathy. CT angiography and/or digital subtraction angiography should be performed, and treatment (including clipping and/or haematoma evacuation) should be conducted promptly, depending on the location of the aneurysm and the clinical situation. Timely diagnosis and suitable treatment are both critical in the management of this rare condition.

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