Surgical Treatment of Traumatic Intracranial Aneurysms: Experiences at a Single Center over 30 Years

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■ OBJECTIVE: **Traumatic intracranial aneurysm (tIA) is rare and is associated with high rates of morbidity and mortality. We describe our experiences with tIA at our institution.**

■ METHODS: **We retrospectively reviewed records from patients who underwent treatment for tIA between January 1986 and December 2015.**

■ RESULTS: **Data from 5532 patients with cerebral aneurysms between January 1986 and December 2015 were reviewed. Of these, 13 cases (0.23%) were tIA. Most occurred after blunt brain trauma (12/13; 92%). The most common location was the distal anterior cerebral artery (7/13; 53%) followed by the internal carotid artery (5/13; 38%). One patient had a tIA in the distal middle cerebral artery. Delayed intracerebral hemorrhage was the major presentation at the time of aneurysmal rupture (70%). Most patients underwent surgical treatment (10/12; 83.3%), which included clipping (5/10), trapping (3/10), aneurysmal excision and bypass (1/10), and aneurysmal excision and coagulation (1/10). In 2 cases, tIA located in the internal carotid artery was treated with coil embolization and detachable balloon occlusion, respectively. Most patients had good recovery (5/12; 41.7%); 3 patients and 1 patient had moderate and severe disability, respectively; 1 patient was in a vegetative state; and 2 patients died.**

■ CONCLUSIONS: **tIA is an uncommon complication of head trauma. tIA should be considered when unexpected new symptoms develop in patients with head trauma. Early diagnosis and prompt treatment could help to improve final clinical outcomes.**

INTRODUCTION

Traumatic intracranial aneurysm (tIA) is rare, constituting <1% of all aneurysms.[1] Most of these aneurysms arise at the skull base or in the distal anterior artery (ACA), middle cerebral artery (MCA), or their branches.[2,3] tIA at a distance from the base of the skull (peripheral tIA) may be due to closed (62%) or penetrating (27%) head trauma or direct iatrogenic vessel injury (11%).[4] tIA is more common in children, with 23%–30% of these aneurysms occurring in patients <18 years old.[5,6] Ruptured tIA manifests with variable clinical symptoms depending on its location. Less commonly, tIA results in subdural hematoma.[7] The mortality rate of tIA can be 50%.[8] The interval from injury to tIA diagnosis varies from several hours to several weeks and, rarely, several years.[9,10]

Owing to use of brain computed tomography (CT) instead of angiography traditionally performed for follow-up surveys of patients with head injuries, tIA is often overlooked, and diagnosis is delayed. Immediate cerebral angiography and early proper treatment are recommended whenever tIA is suspected, as the clinical course of tIA is variable, and the mortality rate is very high. We present our experiences with tIA at our institution over 30 years and identify clues for early diagnosis of tIA.

MATERIALS AND METHODS

Informed consent was obtained from all individual participants included in the study. We retrospectively reviewed data from

Key words
- Delayed intracerebral hemorrhage
- Intracranial aneurysm
- Trauma

Abbreviations and Acronyms
ACA: Anterior cerebral artery
CT: Computed tomography
ICH: Intracerebral hemorrhage
MCA: Middle cerebral artery
SAH: Subarachnoid hemorrhage
tIA: Traumatic intracranial aneurysm

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patients who underwent treatment for cerebral aneurysm between January 1986 and December 2015. Clinical data for each patient included age, sex, type of trauma, aneurysm location, clinical presentation, time elapsed between trauma and operation, treatments, and outcomes. Clinical outcomes were assessed using the Glasgow Outcome Scale at the last follow-up examination except in 2 patients who died (5.2–21 months after treatment). Patients who had a history of intracranial aneurysm and iatrogenic aneurysm (aneurysms related to neurosurgical procedures) were excluded.

RESULTS

Data were reviewed from 5532 patients treated for cerebral aneurysms in our hospital between January 1, 1986, and December 31, 2015. There were 13 cases (0.23%) identified as tIA. The male-to-female patient ratio was 12:1, and average patient age was 31 years (range, 13–65 years). Nearly all tIAs occurred after blunt brain trauma (12 of 13; 92%). Traffic accidents were the most common type of blunt injury associated with tIA (11 of 12; 91.7%). One tIA followed a penetrating injury from metal material ejected after a gas cylinder explosion. Of the 13 cases of tIA, 10 were identified as ruptured aneurysms, whereas 3 were identified incidentally during follow-up examinations. Delayed intracerebral hemorrhage (ICH) was the major presentation at the time of aneurysmal rupture (70%), followed by subarachnoid hemorrhage (SAH) with intraventricular hemorrhage ($n = 1$), ICH with intraventricular hemorrhage ($n = 1$), and massive epistaxis ($n = 1$). Almost all patients underwent cerebral angiography to confirm tIA (92%). The median interval from trauma to operation was 44.6 days (range, 0–119 days). Table 1 summarizes clinical data.

The most common location of tIA was the distal anterior cerebral artery (ACA) (7 of 13; 53%), followed by the internal carotid artery (ICA) (5 of 13; 38%). One patient had a tIA in the distal middle cerebral artery (MCA). Based on histologic features, false aneurysms were observed in 8 cases, and true and mixed aneurysms were seen in 2 cases each.

Most patients underwent surgical treatment (10 of 12; 83.3%), including clipping ($n = 5$), trapping ($n = 3$), aneurysmal excision and bypass ($n = 1$), and aneurysmal excision and coagulation ($n = 1$). The locations of tIA that required surgical treatment included the distal ACA ($n = 7$), ICA ($n = 2$), and distal MCA ($n = 1$). Two cases with tIA in the ICA were treated by coil embolization and detachable balloon occlusion. One patient admitted in the early days of the study period underwent craniotomy, but no procedures to obliterate the aneurysmal sac were performed because of its friability (case 2). The patient was eventually transferred to another hospital for detachable balloon occlusion.

Most patients had good recovery (5 of 12; 41.7%); however, 3 patients had moderate disability, 1 patient had severe disability, 1 patient was in a vegetative state, and 2 patients died. At follow-up, 2 patients had died; 1 patient who underwent aneurysmal trapping died as a result of multiple trauma and pneumonia 45 days after the trauma. The other patient, who also underwent aneurysmal trapping, died of complications of thoracic cavity damage (thoracic empyema and septic shock) 102 days after the trauma.

Illustrative Cases

Case 1. A 16-year-old boy was admitted in a semicomatose state after a motorcycle accident. Neurologic examination revealed a Glasgow

Table 1. Summary Characteristics of Patients with Traumatic Intracranial Aneurysms

Case	Age (years)/Sex	Type of Trauma	Location	Rupture	Clinical Presentation	Elapsed Operation Time (days)	Angiography	Type of Aneurysm	Treatment	Outcome
1	21/M	Blunt (T/A)	ICA (supraclinoid)	–	—	119	+	Mixed	Clipping	Good
2	34/M	Blunt (T/A)	ICA (supraclinoid)	–	—	69	+	False	—	N/A
3	13/M	Penetrating	ACA	+	ICH	0	–	False	Trapping	Dead
4	13/M	Blunt (T/A)	ACA	+	ICH	98	+	True	Clipping	Good
5	21/M	Blunt (T/A)	MCA	+	ICH	19	+	False	Trapping	Dead
6	34/M	Blunt (F/D)	ICA (infraclinoid)	+	Epistaxis	77	+	Unknown	Balloon occlusion	Good
7	42/M	Blunt (T/A)	ACA	+	ICH	2	+	False	Trapping	MD
8	38/M	Blunt (T/A)	ACA	+	ICH	42	+	Mixed	Clipping	Good
9	28/M	Blunt (T/A)	ICA (supraclinoid)	+	SAH with IVH	28	+	False	Clipping	SD
10	56/F	Blunt (T/A)	ACA	+	ICH	27	+	False	Excision and bypass	MD
11	65/M	Blunt (T/A)	ACA	+	ICH	26	+	False	Excision and coagulation	MD
12	16/M	Blunt (T/A)	ICA (supraclinoid)	+	ICH with IVH	58	+	False	Coiling	vegetative
13	22/M	Blunt (T/A)	ACA	–	—	15	+	True	Clipping	Good

M, male; T/A, traffic accident; ICA, internal carotid artery; N/A, not available; ACA, anterior cerebral artery; ICH, intracerebral hemorrhage; MCA, middle cerebral artery; F/D, fall down; MD, moderate disability; SAH, subarachnoid hemorrhage; IVH, intraventricular hemorrhage; SD, severe disability; F, female.