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Bleeding Patterns in Ruptured Posterior Fossa Aneurysms: A CT Study

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Abstract: Computed tomography of the brains in 20 patients with acute rupture of posterior fossa aneurysms was reviewed and analyzed retrospectively. Findings were compared with those from 44 cases described in the literature and with the findings in ruptured supratentorial aneurysms. Extravasated blood was observed in 19 of 20 patients (95%); intraventricular hemorrhage (IVH) in 17 of 20 (85%); and subarachnoid hemorrhage (SAH) in 13 of 20 (65%). These values were significantly higher than those previously reported and suggest that, during the acute phase of rupture, extravasated blood may be detected with the same frequency in either infratentorial or supratentorial ruptured aneurysms. Subarachnoid hemorrhage was accompanied by IVH, prominent in the fourth ventricle and without intraparenchymal hematoma, in 11 patients (55%). This pattern is highly suggestive of ruptured posterior fossa aneurysms. Intraventricular hemorrhage without SAH was noted in five patients (25%) and specifically represented ruptured posterior inferior cerebellar artery aneurysms. Subarachnoid hemorrhage without IVH was noted in only two patients (10%). **Index Terms:** Posterior fossa, aneurysm—Subarachnoid space, hemorrhage—Brain, aneurysm—Computed tomography.

Computed tomography plays an important role in the evaluation of subarachnoid hemorrhage (SAH) due to ruptured aneurysms. Numerous reports have been published regarding its use in the identification of the location of the ruptured aneurysms (1–16). However, these reports have dealt mainly with supratentorial aneurysms (2,4,11,13), and findings in ruptured posterior fossa aneurysms have been described rarely (9,10). The purpose of this paper is the retrospective review and analysis of the acute CT findings in 20 consecutive patients with ruptured posterior fossa aneurysms and an attempt at characterization of specific bleeding patterns.

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MATERIALS AND METHODS

During the period from 1984 to 1990, 20 patients were examined by CT in the acute phase after rupture of posterior fossa aneurysms. All diagnoses were confirmed by arteriography or surgery (Table 1). According to Pia's classification (17), nine of these aneurysms were located at the junction of the vertebral artery and posterior inferior cerebellar artery (VA-PICA), four arose from the distal segment of the PICA, three were at the vertebrobasilar junction (VA-BA), two in the trunk of the basilar artery (BA), and one each in the terminal segment of the vertebral artery (VA) and in the anterior inferior cerebellar artery (AICA). Aneurysms of the basilar bifurcation (basilar tip) were excluded from this study because they are located primarily above the tentorium (10). Intracranial bleeding was verified by CT in 19 patients and by lumbar puncture in 1. Identification of ruptured aneurysms was confirmed by direct surgical verification in 14 patients. In the remaining six patients the diagnosis was established

TABLE 1. *Summary of CT findings and clinical information*

Case/age (years)/sex	Location	SAH	IVH and Grading 4th	3rd	Lat.	Surgery	Other aneurysms
1/69/F	VA-PICA	Diffuse supratentorial, CM	4+	3+	+	+	Internal carotid a. (intracavernous)
2/40/F	VA-PICA	(−)	3+	(−)	+	+	
3/43/M	VA-PICA	Prepontine	+	(−)	(−)	(−)	Superior cerebellar a.
4/47/F	VA-PICA	(−)	4+	2+	+	+	
5/72/F	VA-PICA	Diffuse supratentorial, interpeduncular	+	3+	+	+	
6/62/F	VA-PICA	(−)	3+	(−)	(−)	(−)	
7/58/F	VA-PICA	Diffuse supratentorial, CM	4+	3+	+	+	Anterior communicating a.
8/40/M	VA-PICA	Diffuse supratentorial, prepontine	2+	+	+	(−)	
9/52/M	VA-PICA	CM	4+	3+	+	(−)	
10/52/F	dist-PICA	(−) CH	4+	4+	3+	+	
11/62/F	dist-PICA	(−)	4+	4+	3+	+	Anterior cerebral a.
12/59/M	dist-PICA	(−)	+	(−)	(−)	+	
13/56/F	dist-PICA	Diffuse supratentorial	4+	4+	3+	+	AVM
14/62/M	VA-BA	Prepontine interpeduncular	(−)	(−)	(−)	+	
15/74/M	VA-BA	(−)	(−)	(−)	(−)	+	Superior cerebellar a.
16/36/F	VA-BA	Diffuse supratentorial, CM	3+	(−)	(−)	+	
17/45/M	BA	Diffuse supratentorial, interpeduncular	3+	3+	2+	+	
18/50/F	BA	Diffuse supratentorial	(−)	(−)	(−)	(−)	
19/60/M	dist-AICA	Diffuse supratentorial, CM	2+	(−)	+	(−)	
20/60/M	VA	Diffuse supratentorial, CM, CPA, cerebellopontine	4+	2+	+	+	

AICA, anterior inferior cerebellar artery; AVM, arteriovenous malformation in the right cerebellar hemisphere; BA, basilar artery; CH, cerebellar hematoma; CM, circummesencephalic cistern; CPA, cerebellopontine angle cistern; dist, distal; VH, intraventricular hemorrhage; Lat., lateral ventricle; PICA, posterior inferior cerebellar artery; SAH, subarachnoid hemorrhage; VA, vertebral artery; VA-BA, vertebrobasilar junction; 3rd, third ventricle; 4th, fourth ventricle.

by angiographic demonstration of a solitary posterior fossa aneurysm with features such as spasm suggesting recent ruptures.

The interval from hemorrhage to the initial noncontrast CT was <24 h in 14 patients and from 1 to 3 days after hemorrhage in 6 patients. Five patients had multiple aneurysms, and in this group the determination of which aneurysm had ruptured was made on the basis of radiological and surgical findings. One patient had a saccular aneurysm of the right distal PICA associated with an arteriovenous malformation in the right cerebellar hemisphere. Rupture of the aneurysm in this case was confirmed by surgery.

Subarachnoid hemorrhage occurred in the interhemispheric and sylvian fissures as well as in the suprasellar, circummesencephalic, prepontine, and cerebellopontine angle cisterns. Intraventricular hemorrhage (IVH) was graded from 0 to 4 according to the degree of ventricular filling: grade 1 represented a trace of blood; grade 2, blood occupying <50% of the ventricle; grade 3, >50%; and grade 4, 100%.

RESULTS

As shown in Table 1, extravasated blood was observed in 19 of the 20 (95%) patients, with IVH present in 17 (85%), and SAH in 13 (65%).

Eleven of the 20 (55%) presented with both SAH and IVH (Fig. 1). In 9 of these 11 cases, SAH was symmetrically distributed in the supratentorial subarachnoid space, including the interhemispheric and sylvian fissures and the suprasellar, circummesencephalic, and the prepontine and cerebellopontine angle cisterns. All of the 11 patients had hemorrhage in the fourth ventricle, often denser and more prominent (grade 3 or 4) than the hemorrhage in the third or lateral ventricles. Bleeding in the lateral ventricles was noted in 9 and in the third ventricle in 8 of the 11 patients.

Five of the 20 (25%) patients had only IVH without SAH; all of these patients had ruptured VA-PICA or distal PICA aneurysms (Fig. 2), and IVH was predominant in the fourth ventricle.

Two of the 20 (10%) patients presented only with SAH without IVH. In one patient there was local-

1a–c

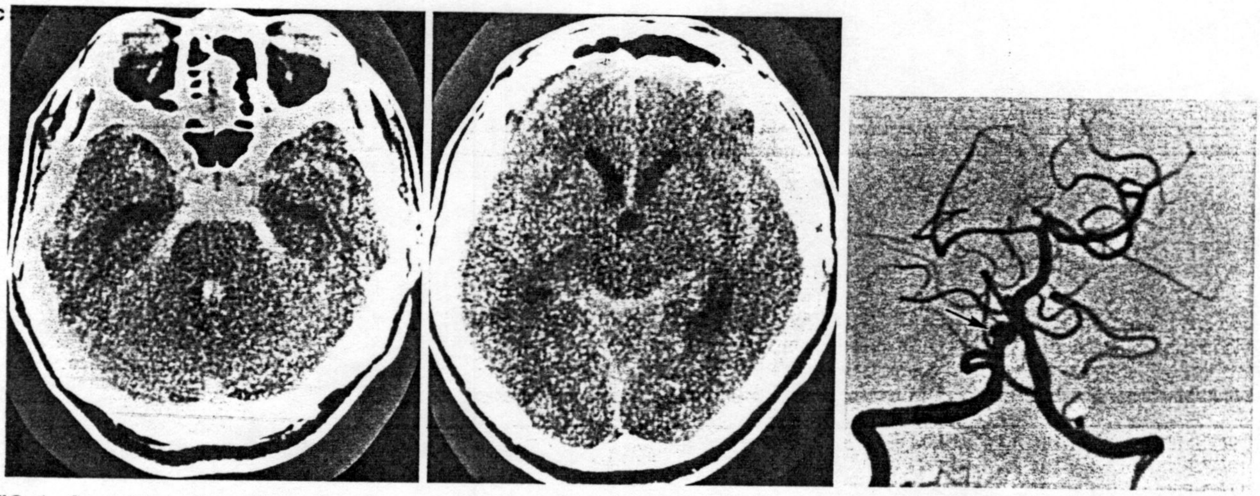

FIG. 1. *Case 20.* **a and b:** Two axial CT scans without contrast medium. There is diffuse subarachnoid hemorrhage in the basal supratentorial subarachnoid space, including the prepontine and circummesencephalic cisterns, and the anterior interhemispheric and sylvian fissures. Intraventricular hemorrhage is also noted in the fourth ventricle. Trace of bleeding was also noted in the third and lateral ventricles in another section (not shown). **c:** Anteroposterior projection of a right vertebral arteriogram shows a saccular aneurysm at the distal vertebral artery on the right (arrow).

ized blood in the circummesencephalic cistern, whereas in the other, diffuse supratentorial SAH was evident. Both of these patients had ruptured VA-BA or BA aneurysms.

One patient (5%) with a ruptured distal PICA aneurysm presented with diffuse IVH and cerebellar hematoma.

One patient (5%) with a ruptured VA-BA aneurysm had no CT evidence of a hemorrhage.

All 13 patients with ruptured VA-PICA and distal PICA aneurysms showed IVH. In 12 of these patients, hemorrhage was most prominent in the fourth ventricle.

None of the seven patients with ruptured aneurysms of VA-BA, BA trunk, VA trunk, and AICA presented only with IVH without concomitant SAH.

DISCUSSION

The CT findings of ruptured infratentorial aneurysms have been described infrequently in case re-

2a–c

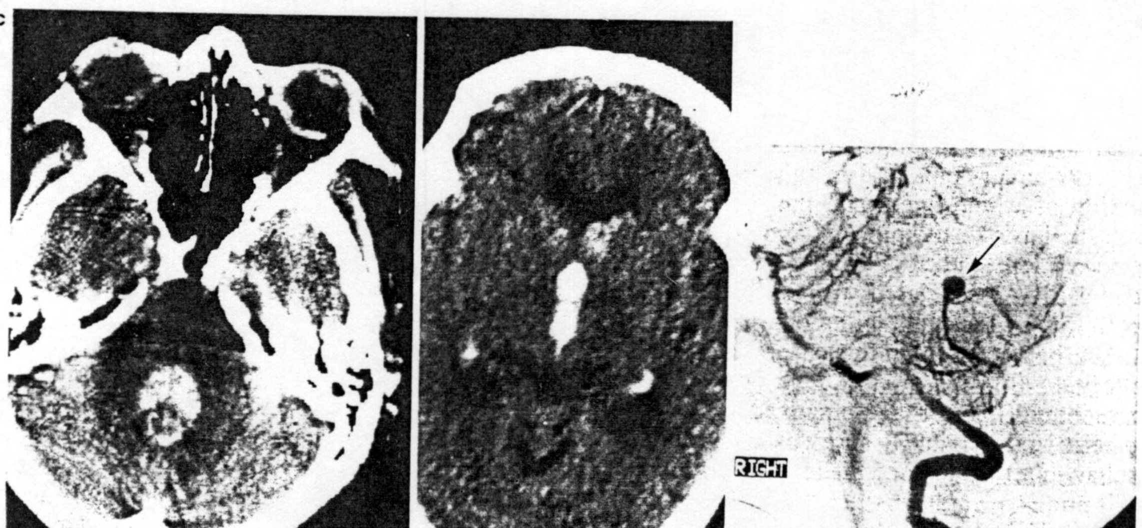

FIG. 2. *Case 11.* **a and b:** Noncontrast CT scans show marked intraventricular hemorrhage, more prominent in the fourth and third than in the lateral ventricles. There was no evidence of subarachnoid hemorrhage in the prepontine and cerebellopontine angle cisterns. High densities lateral to the brachium pontis (a) are artifacts from the petrous bones. **c:** Lateral view of a right vertebral arteriogram shows a saccular aneurysm at the choroidal point of the right posterior inferior cerebellar artery (arrow).

ports or referred to in general discussions of ruptured aneurysms (1–3,7,9–11,18–30). This is apparently due to the rarity of these aneurysms, which comprise 1–2% of all intracranial aneurysms based on angiographic data (17). According to some standard textbooks, ruptured posterior fossa aneurysms frequently present on CT either with normal findings or with SAH adjacent to the brain stem, or rarely with diffuse supratentorial SAH or IVH (13,16). Murtagh et al. have postulated that swelling of the brain stem due to vasospasm may cause narrowing of the circummesencephalic cistern and thus prevent spread of bleeding into the supratentorial cisterns (10). The early descriptions of the CT findings in ruptured posterior fossa aneurysms are summarized in Table 2. Among 44 cases gleaned from the literature, CT demonstrated extravasated blood in 29 patients (66%), SAH in 19 (43%), IVH in 18 (41%), and a combination of SAH and IVH in 8 (18%). Diffuse supratentorial SAH was noted in only 4 patients (9%) and infratentorial SAH in 10 (23%). Our series showed a significantly higher prevalence of extravasated blood (95%) with SAH (65%), IVH (85%), a combination of SAH and IVH (55%), and diffuse supratentorial SAH (50%).

The reason for this significant discrepancy in detecting bleeding between our study and previous reports is not clear. However, it may, in part, be due to the differences in the CT image quality, and differences in timing of CT after the ictus may also have contributed to the discrepancy, since some of the examinations described earlier may not have been performed in the acute phase. Infratentorial SAH was infrequently depicted both by previous authors (23%) and by us (20%), presumably due to bony artifacts, which often hamper the visualization of cisternal blood.

According to previous reports, which dealt mainly with analyzing supratentorial aneurysms, the CT detectability of SAH due to ruptured cerebral aneurysms in the acute phase ranged from 60 to 100% (1,2,12). van Gijn and van Dongen reported the prevalence of SAH as recognized by CT to be 85% after 5 days, 50% after 1 week, 30% after 2

TABLE 2. *Summary of reported cases of ruptured posterior fossa aneurysms*

Publication year	Author (Ref. no.)	Aneurysm Location (No.)+	Location of SAH	Location of IVH	Time of CT after ictus (days)
1977	Liliequist et al. (1)	VA-PICA (1)	Pontine cistern	(−)	?
1980	Zimmerman and and Bilaniuk (9)	VA-PICA (2)	Infratentorial	IV	?
		VA-BA (1)	Infratentorial	IV	?
1980	Liliequist and Lindqvist (7)	VA-PICA (1)	Basal cistern	(−)	?
		VA-PICA (5)	(−)	(−)	?
		BA-AICA (1)	Cerebellopontine	?	?
1981	Silver et al. (11)	VA-PICA (2)	Diffuse supratentorial	III, IV	1
		VA-PICA (1)	(−)	III, IV	1
1981	Murtagh and Balis (10)	VA-PICA (1)	(−)	(−)	0
		VA-PICA (1)	(−)	(−)	?
		VA-PICA (1)	(−)	IV	0
		BA-SCA (1)	(−)	(−)	0
1983	Hudgins et al. (21)	VA-PICA (2)	(−)	III, IV, L	0
		VA-PICA (2)	Basal cistern	(−)	0
		VA-PICA (1)	(−)	IV	0
		VA-PICA (2)	(−)	(−)	0
		VA-PICA (1)	Basal cistern	III, IV	0
1984	Yamada et al. (22)	dist-PICA (2)	Prepontine	(−)	?
		dist-PICA (2)	Prepontine, basal cistern	(−)	10
1985	West and Forbes (15)	VA-PICA (1)	Diffuse supratentorial	III, L	?
1985	Nishizaki et al. (24)	dist-PICA (1)	(−)	IV	3
		dist-PICA (2)	(−)	(−)	?
1985	Kawase et al. (23)	BA-AICA (1)	(−)	III, IV	1
		VA-BA (1)	Basal cistern	(−)	1
1985	Yeh et al. (25)	dist-PICA (3)	(−)	III, IV, L	0
1986	Pasqualin et al. (27)	dist-PICA (1)	Sylvian fissure, cistern magna	IV	?
1986	Beyerl and Heros (26)	dist-PICA (1)	(−)	(−)	?
1988	Dernbach et al. (28)	dist-PICA (1)	(−)	(−)	?
1988	Giannotta and Maceri (29)	VA-BA (1)	Diffuse supratentorial	?	0
		BA-AICA (1)	(−)	(−)	0

BA-AICA, junction of basilar artery and anterior inferior cerebellar artery; BA-SCA, junction of BA and superior cerebral artery; dist, distal; (No.)+, number of patients having same bleeding locations; IV, 4th ventricle; III, 3rd ventricle; IVH, intraventricular hemorrhage; L, lateral ventricle; SAH, subarachnoid hemorrhage; VA-BA, vertebrobasilar junction; VA-PICA, junction of vertebral artery and posterior inferior cerebellar artery; ?, not mentioned.

weeks, and nearly nil after 3 weeks (12). After comparing these data with ours, we conclude that, during the acute phase of rupture, extravasated blood from infratentorial aneurysms will be detected as often as that from supratentorial aneurysms.

A variety of SAH patterns can be recognized on CT, depending on the location of the ruptured aneurysms. Anterior cerebral artery aneurysms, especially those of the anterior communicating artery (Acom), tend to bleed into the anterior interhemispheric fissure (AIF), the suprasellar cistern, and the sylvian fissures bilaterally (8,11). Aneurysms of the internal carotid and posterior communicating artery (Pcom) tend to bleed into the suprasellar cistern and the adjacent sylvian fissure with blood rarely entering the AIF. Middle cerebral artery (MCA) aneurysms invariably bleed into the sylvian fissure and suprasellar cistern, and less frequently into the AIF (2,11). Aneurysms arising from the tip of the BA bleed into the interpeduncular, the circummesencephalic, and the suprasellar cisterns, and bleeding into the sylvian fissure and the AIF is uncommon (9,11). These findings of cisternal blood are often nonspecific for the localization of ruptured aneurysms (5,8,11,14).

Supratentorial SAH from the infratentorial aneurysms is invariably distributed in symmetric fashion. Infratentorial SAH was noted in only 20% of the patients and half of them were accompanied by supratentorial SAH. Thus, in patients with infratentorial aneurysms, the patterns of cisternal blood are not specific for bleeding sites.

Localization of ruptured aneurysms by CT can be greatly enhanced if localized hematomas are present (5,14). Approximately 20–30% of patients with ruptured supratentorial aneurysms will have an associated intracerebral hematoma (8,11,31). Hematomas in the cisterna lamina terminalis and/or septum pellucidum are present in ruptured Acom aneurysms (8,11). Temporal lobe and basal ganglia hematomas occur with MCA, Pcom, and internal carotid artery aneurysms (2). Midbrain or hypothalamic hemorrhages associated with SAH are highly suggestive of ruptured basilar tip aneurysms (9,11). These hematomas associated with ruptured supratentorial aneurysms may rupture into the third or lateral ventricles (8,9,11).

We only encountered one patient (5%) with a ruptured distal PICA aneurysm with cerebellar hematoma. Although distal PICA aneurysms are rare, they should be included in the differential diagnosis of cerebellar hematoma along with hypertensive or tumor bleeding (30).

Intraventricular hemorrhage was noted quite frequently in our study, being present in all of the VA-PICA and distal PICA aneurysms. Intraventricular hemorrhage of ruptured posterior fossa aneurysms showed characteristic features, i.e., more prominent blood in the fourth than in the third and lateral ventricles, symmetrical blood distribution in the lateral ventricles, and absence of parenchymal hematoma.

In previous studies mainly based on ruptured supratentorial cerebral aneurysms, IVH was observed in 13 to 28% of the cases in the clinical series (11,19,32) and in 37 to 54% of the cases in the autopsy series (33,34). Most of the IVH probably resulted from direct rupture of intracerebral or subarachnoid hematomas into the ventricular system (35). Intraventricular hemorrhage without associated intraparenchymal hemorrhage was less frequent, noted in 10 to 28% of all ruptured aneurysms (15,36). However, ruptured posterior fossa aneurysms presented with IVH without intraparenchymal hemorrhage more frequently than the supratentorial aneurysms as noted in previous reports (9,11,13,21), and even more strikingly in the present study. The main reason for this is presumably the fact that bleeding sites are often close to the outlets of the ventricular system. In particular, the PICA runs close to the foramina of Luschka and Magendie (25), and hemorrhage from an aneurysm of this artery can be expected to flow easily in retrograde fashion into the fourth ventricle.

We conclude that hemorrhage due to ruptured posterior fossa aneurysms can frequently be depicted by CT, and the aneurysm sites can be localized. Intraventricular hemorrhage predominantly involving the fourth ventricle without intraparenchymal hemorrhage is a characteristic feature of ruptured posterior fossa aneurysm. Contrary to previous reports, diffuse supratentorial SAH is not a rare finding in posterior fossa aneurysms and when coexisting with IVH of the pattern described above, it is strongly suggestive of the diagnosis.

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