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Comparison between perimesencephalic nonaneurysmal subarachnoid hemorrhage and subarachnoid hemorrhage caused by posterior circulation aneurysms

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Object. Some authors have questioned the need to perform cerebral angiography in patients presenting with a benign clinical picture and a perimesencephalic pattern of subarachnoid hemorrhage (SAH) on initial computerized tomography (CT) scans, because the low probability of finding an aneurysm does not justify exposing patients to the risks of angiography. It has been stated, however, that ruptured posterior circulation aneurysms may present with a perimesencephalic SAH pattern in up to 10% of cases. The aim of the present study was twofold: to define the frequency of the perimesencephalic SAH pattern in the setting of ruptured posterior fossa aneurysms, and to determine whether this clinical syndrome and pattern of bleeding could be reliably and definitely distinguished from that of aneurysmal SAH.

Methods. Twenty-eight patients with ruptured posterior circulation aneurysms and 44 with nonaneurysmal perimesencephalic SAH were selected from a series of 408 consecutive patients with spontaneous SAH admitted to the authors' institution. The admission unenhanced CT scans were evaluated by a neuroradiologist in a blinded fashion and classified as revealing a perimesencephalic SAH or a nonperimesencephalic pattern of bleeding.

Of the 28 patients with posterior circulation aneurysms, five whose grade was I according to the World Federation of Neurosurgical Societies scale were classified as having a perimesencephalic SAH pattern on the initial CT scan. The data show that the likelihood of finding an aneurysm on angiographic studies obtained in a patient with a perimesencephalic SAH pattern is 8.9%. Conversely, ruptured aneurysms of the posterior circulation present with an early perimesencephalic SAH pattern in 16.6% of cases.

Conclusions. This study supports the impression that there is no completely sensitive and specific CT pattern for a nonaneurysmal SAH. In addition, the authors believe that there is no specific clinical syndrome that can differentiate patients who have a perimesencephalic SAH pattern caused by an aneurysm from those without aneurysms. Digital subtraction angiography continues to be the gold standard for the diagnosis of cerebral aneurysms and should be performed even in patients who have the characteristic perimesencephalic SAH pattern on admission CT scans.

KEY WORDS • idiopathic subarachnoid hemorrhage • perimesencephalic bleeding • posterior circulation aneurysm • angiography

In nearly 15% (range 5–34%) of patients with nontraumatic SAH, no obvious source of hemorrhage can be demonstrated despite performance of high-quality four-vessel cerebral angiography.[2,11,12,21,23,32,33,41] The prognosis for this group of patients is significantly better than for those with aneurysmal bleeding.[11,12,32,33,41] Although on repeated angiography vascular abnormalities are identified in 2 to 24% of patients, the cause of hemorrhage remains unknown in the majority of the cases.[2,5,7,9,14,23,27,30,41] Within the group of patients with nonaneurysmal SAH there is a subset in whom a pattern of pure perimesencephalic SAH is demonstrated on the initial CT scan. Their clinical course is even better than that of the remaining patients with nonaneurysmal SAH and, of course, it is much better than that of patients suffering from aneurysmal SAH.[4,20,35,41] This entity was defined by van Gijn, et al.,[35] as nonaneurysmal perimesencephalic SAH.

It has been stated, however, that ruptured aneurysms of the posterior circulation may present with the pattern of perimesencephalic SAH on CT scans in up to 10% of cases.[15,18,19,24,28,35,41] In addition, some authors have reported that ruptured aneurysms of the anterior circulation may also cause the perimesencephalic SAH pattern on the initial CT scan.[34] Thus, the question that arises is what is the likelihood of finding an aneurysm on the initial angiographic studies when CT scans reveal a perimesencephalic SAH pattern. Another related question is what percentage of aneurysms present with this pattern of bleeding.

The purpose of our study was twofold. First, in a consecutive series of patients with SAH, we attempted to define

Abbreviations used in this paper: BA = basilar artery; CT = computerized tomography; DS = digital subtraction; IVH = intraventricular hemorrhage; MR = magnetic resonance; PCA = posterior cerebral artery; SAH = subarachnoid hemorrhage; VA = vertebral artery; WFNS = World Federation of Neurosurgical Societies.

TABLE 1

*Clinicoradiological features of 44 patients with perimesencephalic nonaneurysmal SAH compared with 28 patients with posterior circulation aneurysms**

Feature	PMSAH	
	Nonaneurysmal	W/ Posterior Circ Aneurysm
male/female	63.6:36.4	46.4:53.6
age (yrs)		
mean	51.9	53.4
range	34–84	28–74
% of patients w/		
previous hypertension	25.0	46.4
warning headache	11.4	32.1
loss of consciousness	2.3	53.6
straining-related SAH	15.9	7.1
WFNS grade		
I	86.4	57.1
II	11.4	25.0
III	2.3	7.1
IV	0	7.1
V	0	3.6
early CT (<48 hrs)	93.2	85.7
IVH		
none	79.5	35.7
mild	20.5	60.0
hydrocephalus	9.1	17.9

* Circ = circulation; PMSAH = perimesencephalic SAH.

the frequency of perimesencephalic SAH patterns in the setting of ruptured posterior fossa aneurysms and to compare the clinicoradiological presentation of patients with ruptured posterior circulation aneurysms with those in whom nonaneurysmal perimesencephalic SAH was revealed on early CT scans. Second, by using the perimesencephalic SAH criteria defined by van Gijn, et al.,[35] we also investigated whether this pattern of bleeding could be reliably and definitely distinguished from that of aneurysmal SAH. For this purpose, we assessed the percentage of patients with this pattern of bleeding in whom an aneurysm was later found.

Clinical Material and Methods

From a total of 408 patients with spontaneous SAH consecutively admitted to our department between 1990 and 2000, we selected those in whom angiography disclosed an aneurysm of the posterior circulation located either at the VA, BA, posterior inferior cerebellar artery, anterior inferior cerebellar artery, superior cerebellar artery, or the PCA (a total of 28 cases). For the purpose of the study we also selected patients in whom angiographic results were normal and in whom the initial CT scans revealed the perimesencephalic SAH pattern of bleeding as defined by van Gijn, et al.[35] (44 cases).

The diagnosis of SAH was confirmed by the presence of a typical history of spontaneous SAH and blood in the basal cisterns observed on the admission CT scan. All patients underwent four-vessel cerebral angiography. The clinical grade was evaluated in the Emergency Department according to the WFNS scale for SAH.[4] Age of the patient, history of hypertension, occurrence of initial loss of consciousness, seizures after the stroke, and the time interval (days) between the stroke and hospital admission, as well as between the stroke and initial CT scan, were recorded. Patients and their relatives were asked about previous symptoms consistent with minor leaks. Symptoms attributed to a minor leak were severe generalized or localized headache of acute onset, with or without nausea or vomiting, in a patient with no history of similar recurrent headache.

A CT scan was performed in all cases and the presence and amount of cisternal blood was evaluated by using the Fisher scale.[6] The amount of IVH was classified as none, small, moderate, and diffuse. Hydrocephalus was recorded as present when the Evans index, that is, the ratio of the largest width of the frontal horns to the maximal biparietal diameter, was greater than 30%.

To determine whether a nonaneurysmal pattern of bleeding could be distinguished from an apparently similar aneurysmal one on early CT scans, the initial unenhanced scans were evaluated by an experienced neuroradiologist in a blinded fashion and classified as showing a perimesencephalic or a nonperimesencephalic pattern. Our definition of a perimesencephalic SAH pattern was based on van Gijn, et al.,[35] and Rinkel, et al.,[28] whose criteria include the following: 1) center of bleeding located immediately anterior to the midbrain; 2) possible extension of blood to the posterior part of the anterior interhemispheric fissure, without complete filling of the anterior interhemispheric fissure; 3) extension of blood to the basal part of the sylvian fissure permitted, but not extension to the lateral sylvian fissure, except for minute amounts of blood; 4) sedimentation of small amounts of intraventricular blood allowed, but not frank IVH; and 5) absence of intracerebral hematoma.

Results

The clinicoradiological features of patients selected for the study are presented in Table 1.

Posterior Circulation Aneurysms

Clinical Features. There were 28 patients with a total of 33 aneurysms; one patient had two lesions and another had five, but only the one causing the bleeding was located in the infratentorial compartment. Thus, 28 posterior circulation aneurysms were detected, 15 in the BA, 12 in the VA–posterior inferior cerebellar artery complex, and one in the PCA. Twenty-five were saccular in shape, one was fusiform, and two were dissecting aneurysms. The lesions were small (< 10 mm) in 15 cases, medium (10–25 mm) in 12, and giant (> 25 mm) in one.

Of the 28 patients, 13 were men and 15 were women whose ages ranged from 28 to 74 years (mean 53 years). In this group, 46.4% had a history of arterial hypertension, and 32% of patients had a premonitory minor leak triggering a headache for which some had sought treatment in the Emergency Department in the previous weeks. Loss of consciousness was present in 53.6% of patients, and in only two of the 28 were the symptoms associated with straining or vigorous physical activity. Two patients suffered a seizure during the stroke. No cranial nerve palsies were seen.

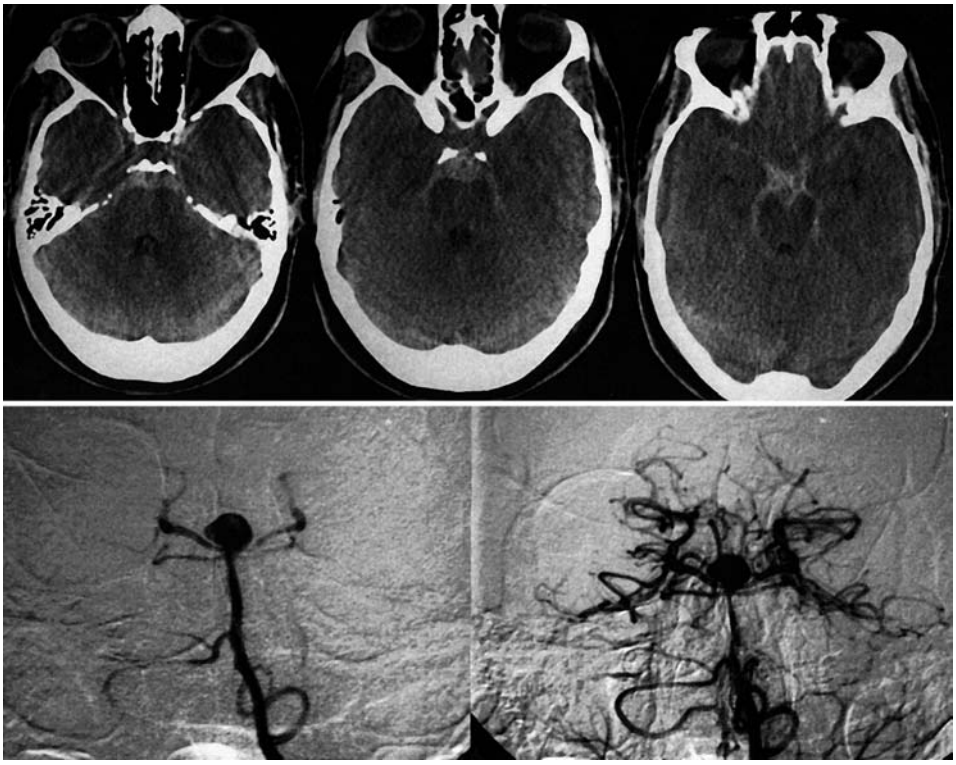

FIG. 1. *Upper:* Axial CT scans obtained in a patient who experienced sentinel headache. He had no history of arterial hypertension, no loss of consciousness, and results of his clinical examination were normal. A pure perimesencephalic pattern of bleeding is revealed on the initial CT scan. *Lower:* Anteroposterior view of the DS angiography studies demonstrating an aneurysm at the tip of the BA.

In 82% of patients the clinical grade of SAH according to the WFNS scale was I or II.

Neuroradiological Features. Twenty-four (86%) of the 28 patients underwent CT scanning within 48 hours postictus and 18 (64%) were classified as having Fisher Grade 4 lesions.[6] Seventeen (61%) of the patients presented with mild IVH and one presented with frank intraventricular bleeding. A significant intraparenchymal hematoma (> 20 cm^3) was found in only one case on the initial CT scan. Hydrocephalus was present in five patients (18%), all of whom needed ventriculoperitoneal cerebrospinal fluid shunting. Also, five patients (18%) were classified as having a perimesencephalic SAH pattern of bleeding on the initial CT scan.

Perimesencephalic Nonaneurysmal SAHs

Clinical and Neuroradiological Features. Of the 44 patients with nonaneurysmal perimesencephalic SAH patterns, 28 were men and 16 were women; their ages ranged from 34 to 84 years (mean 51.9 years). Of these patients, 25% had a history of arterial hypertension and 11.4% had experienced a sentinel headache during the previous days. Only one patient (2.3%) suffered loss of consciousness accompanying the headache. In 15.9% of these patients, the symptoms were associated with some type of straining. No patient had seizures during or after the stroke. The clinical grade according to the WFNS scale was I or II in 97.8% of the patients.

Initial CT scanning was performed within the first 48 hours after the SAH in 41 patients (93.2%). Mild IVH was present in 20.5% of the cases, and although in four of them (9.1%) hydrocephalus was present, only one patient required ventriculoperitoneal cerebrospinal fluid shunting.

Posterior Circulation Aneurysms Presenting as Perimesencephalic SAH on Initial CT Scan

Of the five patients presenting with the perimesencephalic SAH pattern, three were men and two were women; their ages ranged from 39 to 58 years. Four of them were free of previous arterial hypertension, two had experienced a sentinel headache during the previous days, and only one suffered loss of consciousness during the stroke. The clinical grade according to the WFNS scale was I in all patients.

The initial CT scan was performed within 48 hours of stroke in four of these patients and 96 hours later in the other. Angiography showed a BA aneurysm in four cases and a VA aneurysm in one (Fig. 1). Four aneurysms were medium sized (10–25 mm) and one was small (< 10 mm).

Considering only patients who underwent CT scanning within the first 48 hours posthemorrhage, we found that the likelihood of finding an aneurysm on angiographic studies obtained in a patient who had a perimesencephalic SAH pattern was 8.9% (four of 45 patients with a perimesencephalic SAH pattern). Conversely, our data indicate that ruptured aneurysms of the posterior circulation present with an early perimesencephalic SAH pattern in 16.6% of pa-

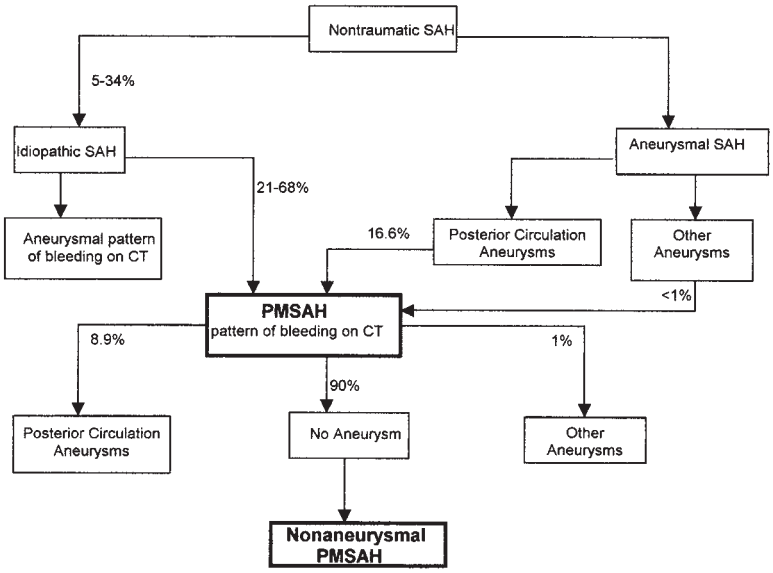

FIG. 2. Chart showing prevalence of posterior circulation aneurysms in patients with a perimesencephalic pattern of bleeding after SAH.

tients (four of 24 total cases of posterior circulation aneurysms).

Discussion

In 1985, van Gijn, et al.,[35] reported on a subset of patients with SAH whose angiograms were nondiagnostic, in whom the initial CT scan demonstrated that the blood was primarily limited to the perimesencephalic cisterns. These investigators defined the perimesencephalic SAH pattern of hemorrhage as a ". . . centre of the hemorrhage located in front of the brainstem, mainly in the interpeduncular cistern, with or without extension to the ambiens, chiasmatic and horizontal part of the Sylvian cisterns and no intraventricular blood, except what could be accounted for by sedimentation effects." The clinical course of this group clearly differed from that of patients with aneurysmal SAH, in that loss of consciousness at the time of presentation was rare and the final outcome was typically excellent. These authors called the new clinical entity "nonaneurysmal perimesencephalic SAH" and stated that finding this pattern of SAH on the initial CT scan was almost synonymous with a nonaneurysmal source of bleeding and a good outcome. Subsequently, other authors confirmed the rather characteristic CT and clinical picture of this entity.[14,19,24,27,28,30,33,41] In the original article, van Gijn, et al., postulated a nonarterial source of the hemorrhage based on the slower onset of headache, the infrequent loss of consciousness, the lack of blood in the brain parenchyma, and the benign clinical course; in addition, they paid special attention to the venous phase of the angiographic study, which revealed no abnormalities. Other authors have proposed alternative sources of bleeding in this setting,[2,28,31,40] although recent studies conducted with MR imaging in such patients have also failed to show a definite source of the bleeding.[10,25,28,30,41]

In 5 to 34% of all patients with nontraumatic or spontaneous SAH no vascular malformation is demonstrated on the initial four-vessel angiography (Fig. 2).[2,11,12,21,23,32,33] For reasons that remain unexplained, the incidence of SAH of unknown origin is higher in our country than in others, reaching 27 to 34% of the total cases.[11,12,21]

Repetition of the angiographic studies after 2 to 3 weeks has been recommended by us and other authors only in patients who have either a nonperimesencephalic pattern of bleeding on the initial CT scan or vasospasm on the initial angiogram, because in some cases aneurysms have been detected on the second angiogram.[9,12,20,27,32,33] Such a finding is not expected, however, in patients presenting with a perimesencephalic SAH pattern initially.

Nonaneurysmal perimesencephalic SAH has been reported to be present in 8 to 11% of all nontraumatic SAHs and in 21 to 68% of all cases with nondiagnostic angiograms or with idiopathic SAH (Fig. 2).[10,32,33,35,41] These figures may vary, however, with the timing of CT scanning, the quality of angiographic studies, the definition of perimesencephalic SAH, the inclusion of patients whose CT findings were nondiagnostic, and the study design. The importance of timing of the initial CT scan was shown in one report in which CT studies that were repeated 1 week after stroke revealed complete washout of blood in 92% of patients in whom perimesencephalic SAH was demonstrated on the initial CT examinations.[28] If the initial CT scan is performed 72 to 96 hours postictus, an incomplete washout of blood could mimick the pattern of perimesencephalic SAH in a patient in whom an earlier CT scan would have shown a more typical aneurysmal pattern of bleeding. This is why we excluded from the analysis those patients whose initial CT scans were performed more than 48 hours postictus.

Several authors have called our attention to the fact that ruptured aneurysms of the posterior circulation may present sometimes with the pattern of perimesencephalic SAH on the initial CT scan. Different studies have shown that up to 10% of cases of perimesencephalic SAH are caused by the rupture of a posterior circulation aneurysm, and in turn be-

tween 7.1 and 11.8% of ruptured posterior circulation aneurysms present with a perimesencephalic SAH pattern on the initial CT scan (Table 2 and Figs. 1 and 2).[10,15,18,19,24,26,33,35,36] In addition, there are case reports of vertebrobasilar artery, PCA, and posterior communicating artery aneurysms causing perimesencephalic SAH.[8,15,18,22,24,30]

van der Jadt, et al.,[34] investigated the diagnostic value of the blood distribution on early CT scans for determining the site of ruptured aneurysms in 168 patients with SAH. Computerized tomography scans were studied by two experts who were unaware of the final result of cerebral angiography. In 39 patients (23%) no aneurysms were found. These two observers agreed on the site of the ruptured aneurysm in only 52% of the cases. Nonaneurysmal SAH was predicted by Observer 1 in one patient who actually had an internal carotid artery aneurysm, and by Observer 2 in five patients (correct in three patients, whereas one patient had an anterior communicating artery aneurysm and another had an internal carotid artery aneurysm). Conversely, in 46% of the patients who actually had a nonaneurysmal hemorrhage, a ruptured posterior circulation aneurysm was predicted. Both observers had the lowest accuracy of prediction in cases of nonaneurysmal SAH.

The data from our series show that ruptured aneurysms of the posterior circulation present a pattern of perimesencephalic SAH on early CT scans in 16.6% of cases, and that 9% of all perimesencephalic SAH presentations were due to the rupture of a posterior circulation aneurysm. In addition, the initial clinical data in these patients could have convinced us to diagnose a benign nonaneurysmal perimesencephalic SAH, because four of them had no history of arterial hypertension, only one of them had loss of consciousness, and all were admitted in a good clinical grade (WFNS Grade I). Thus, our findings indicate that a completely or highly sensitive and specific CT pattern for a nonaneurysmal SAH is unlikely to be found, because aneurysms from different locations, particularly those of the BA tip, may exhibit the perimesencephalic SAH pattern of bleeding.

The typically benign course of nonaneurysmal perimesencephalic SAH has led some authors to question the need to perform cerebral angiography in patients with a benign clinical presentation and perimesencephalic SAH on the initial CT scan, arguing that it is not worth risking an invasive procedure in such cases.[29,36] Ruigrok, et al.,[29] in a complex decision analysis study that took into consideration the risks of cerebral angiography on one hand, and the risks of rebleeding from an undetected aneurysm on the other, concluded that the best diagnostic strategy in patients with a perimesencephalic SAH is to perform only CT angiography. The results of that study could be biased, however, because they give a 4% chance of finding a vertebrobasilar artery aneurysm in patients with perimesencephalic SAH and a 97% sensitivity and specificity for CT angiography. We believe that neither such a high prediction capability for nonaneurysmal perimesencephalic SAH nor such a high accuracy rate for CT angiography can be achieved in every neurosurgical unit. In a recent prospective study of 1000 consecutive cerebral diagnostic angiography studies, the overall incidence of neurological deficit was 1% and the incidence of persistent deficit was only 0.5%; moreover, all the complications occurred in patients who underwent angiography because of stroke or transient ischemic attacks, and no complications were seen in the subgroup of patients suffering SAH.[13]

TABLE 2

*Literature review of the relationship between posterior circulation aneurysms and the presence of a perimesencephalic pattern of SAH on CT scans**

		Posterior Circ Aneurysms		
Authors & Year	No. W/ PMSAH	% W/ PMSAH & Aneurysm	Total No.	% of Aneurysms W/ PMSAH
van Gijn, et al., 1985	14	7.0	NR	NR
Kayama, et al., 1991	NR	NR	34	11.8
Rinkel, et al., 1991	23	4.0	NR	NR
Goergen, et al., 1993	9	0	NR	NR
Kitahara, et al., 1993	11	9.0	48	10.4
Pinto, et al., 1993	38	2.7	81	1.3
Van Calenbergh, et al., 1993	NR	2.7	NR	NR
Kallmes, et al., 1996	NR	NR	169	7.1
Velthuis, et al., 1999	15	0	NR	NR
present study†	45	8.9	24	16.6

* NR = not reported.

† Computerized tomography was performed in the first 48 hours after the stroke.

In more recent studies, researchers have attempted to validate the use of CT angiography as an alternative to DS angiography for the diagnosis of cerebral aneurysms.[1,39] In a systematic review of the studies appearing in the literature between 1988 and 1998, White, et al.,[39] concluded that CT and MR angiography depicted aneurysms with an accuracy of approximately 90%, the percentage being even lower for aneurysms smaller than 3 mm (61% sensitivity for CT angiography). They also concluded that the negative predictive value of CT angiography was 80%, which means a higher number of false-negative results. In addition, they called our attention to the fact that most of the published studies had been performed in populations with a high prevalence of aneurysms, and that in many of the analyses there was a consensus review between two or more readers, which might have introduced a bias toward noninvasive examinations. On the other hand, it should be noted that in regular clinical practice, interpretation of CT angiography is usually made by one radiologist only, and patients presenting with perimesencephalic SAH have a low prevalence of aneurysms.

In another study, Anderson, et al.,[1] estimated that the sensitivity of CT angiography for detecting all aneurysms was 84%, and they had even more problems with the detection of small unruptured aneurysms and in patients presenting with multiple lesions. They also pointed out that the information provided by CT angiography was considered by neurosurgeons to be insufficient to warrant an operation in 52% of cases. Nevertheless, recently published studies favor the use of CT angiography over DS angiography because it is less invasive and it is at least as sensitive for detecting cerebral aneurysms.[16,17,37,38,42]

Unfortunately, the low prevalence of aneurysms in the group of patients with the perimesencephalic SAH pattern of bleeding makes it difficult to compare the diagnostic accuracy of DS and CT angiography for detecting aneurysms. Although it is still uncertain which of these two modalities is superior, the combination of both would probably enable

us to detect a small aneurysm in the posterior circulation more accurately than either one used alone.

Conclusions

Data from the present and previous studies have convinced us that the conservative approach in patients presenting with the perimesencephalic SAH pattern on early CT scans cannot be recommended. Because there is no specific clinical syndrome that can differentiate between patients who have a perimesencephalic SAH pattern caused by an aneurysm and those who do not, and because a CT pattern of SAH that is completely sensitive and specific for a nonaneurysmal origin has not yet been found, the probability of missing an aneurysm remains relatively high. On the other hand, the risks associated with DS angiography have been reported to be very low in a recent systematic review,[3] indicating that new diagnostic tools such as CT or MR angiography should not yet replace DS angiography, which continues to be the gold standard for the diagnosis of cerebral aneurysms. In our opinion, DS angiography should be performed alone or in combination with CT angiography in patients in whom a perimesencephalic SAH pattern is demonstrated on CT scans.

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