PITFALLS IN THE DIAGNOSIS OF SUDDEN HEADACHE*

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It would be more than a little pedantic to begin this article by defining what headache is, but the term 'sudden' deserves some qualification. I shall limit the scope of my review to types of headache that come on in seconds ('a flash', 'just like that', 'a bolt from the blue', 'as if I was hit on the head'), or in a few minutes at most. Patients may also use the word 'sudden' to describe an episode of headache that came on in about half an hour or longer, depending on the interval after which the history is given.

Far more serious than over-diagnosing sudden headache is not recognising it. This potential pitfall occurs at the very start of the diagnostic process for general practitioners or any other physician seeing the patient soon after the symptom has developed; one should not expect that this piece of information is offered on a silver tray. Just imagine a typical scenario. The general practitioner has received an urgent call about a man in his fifties with an unbearable headache. He may have been a frequent visitor to the surgery, perhaps with symptoms of tiredness and erectile dysfunction. On entering the house the family physician catches a glimpse of the patient lying down on the couch, his head covered with a wet towel. Before he can do anything further the worried spouse and her daughter shower him with questions: Do you think it is serious, doctor? Do you think I ought to call our son in Canada? Should I try and give him his tea? Should I cancel the holiday we have booked next week? Can you please tell him to work a little less hard? etc. Under such circumstances, so very different from the examination situation when a 'case' has been made all ready for the candidate's questions, it is very difficult to keep a cool head as a physician and not to forget to ask the vital question about how it all started. It is therefore no wonder that subarachnoid haemorrhage, a fairly frequent cause of sudden headache, is often misdiagnosed as sinusitis, muscle strain, migraine, 'flu, or mental stress.[1]

Patients with headache may also present to an Accident and Emergency Department, where they constitute around 1% of all attendances.[2] The proportion with serious neurological conditions ranges from 16% for all patients with headaches regardless of referral,[2] to 75% for those with episodes of sudden headache referred to a neurologist.[3] The three main causes of sudden headache are subarachnoid or other intracranial haemorrhage, other serious brain disorders, and functional syndromes that are not life-threatening. Table 1 lists the frequencies of these three categories in the setting of primary care as well as in that of a neurology service in a university hospital.

TABLE 1
Causes of sudden headache, according to frequency[3,5]

	general practice	*hospital series (neurological referrals)*
intracranial haemorrhage (aneurysmal, non-aneurysmal perimesencephalic, primary intraventricular, intercerebral, cerebellar, subdural)	25%*	50%
other serious brain disorders (intracranial venous thrombosis, arterial dissection, colloid cyst)	12%	25%
functional syndromes (idiopathic thunderclap headache, benign exertional headache, venous strain, related to sexual activity, 'icepick' headache)	63%	25%

* 12% if headache is the *only* symptom

INTRACRANIAL HAEMORRHAGES

Subarachnoid haemorrhage

General practitioners have the most difficult role, as they encounter subarachnoid haemorrhage only once every eight years on average, given its annual incidence of 6/100,000.[4] This may of course mean not seeing such a patient for 20 years and then seeing two within a few months. The symptoms of subarachnoid haemorrhage consist solely of headache in about one third of the patients, with or without vomiting.[5] Another common manifestation is loss of consciousness, occurring in around 60% (50% in a large hospital series,[6] but in addition 10-12% of patients die at home or during transportation).[5,7] Less typical manifestations are seizures (6-9%),[8,9] delirium, focal stroke (resulting from an intracerebral haematoma), and non-specific 'dizziness'. Physical exertion or sexual excitement may, and often do, precede acute subarachnoid haemorrhage but they also precede migrainous or other less life-threatening causes of sudden headache.[10]

Contrary to what medical students are often taught, physical examination is of little help soon after the onset of suspected subarachnoid haemorrhage, since the classical signs of meningeal irritation take hours to develop.

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Subhyaloid haemorrhages occur in only 20-40% of patients, usually in those with a decreased level of consciousness,[11,12] and are unlikely to be detected in the course of an examination in the patient's home environment. Ocular palsies, if they occur, will be obvious but are infrequent: disorders of eye movement usually involve the abducens nerve, and sometimes the oculomotor nerve.[13]

Investigations are essential in making the diagnosis of subarachnoid haemorrhage, given that the clinical features are usually non-specific.[14] CT scanning will identify most, but not all, patients with the presence of blood in the subarachnoid space. The proportion of positive CT scans depends on the interval from the onset of symptoms, decreasing from 98% within 12 hours to 50% after one week.[3,15] Assessment by an experienced radiologist is implied in these proportions, as on some of these scans the changes may be very subtle, with only a single cistern showing slight hyperdensity, or rather a lack of hypodensity (Figure 1A,B,C). Lumbar puncture is indicated in patients with a negative CT scan and a convincing history of headache with sudden onset that is still present at the time the patient is seen. Two percent of subarachnoid haemorrhages are picked up only in this way; given the proportion of functional headaches in hospital series, approximately 30 negative lumbar punctures are needed to find one such case.[3] Of course this ratio may vary between hospital services, according to local patterns of referral, but in terms of patient discomfort and hospital investment it is an acceptable trade-off against the 3% risk of sending a patient home with a recently-ruptured cerebral aneurysm.

Lumbar puncture should not be carried out rashly, or without some background knowledge. A first rule is that at least six, and preferably 12, hours should have elapsed between the onset of headache and the spinal tap. This will often imply that the patient is removed from the Accident and Emergency Department to a clinical ward, if only for a short time. The delay is essential because, if there are red cells present in the CSF, sufficient lysis will have taken place during that time for bilirubin and oxyhaemoglobin to have been formed.[16] These pigments give the CSF a yellow tinge after centrifugation (xanthochromia), a critical feature in the distinction from a traumatic tap; the pigments are invariably detectable until at least two weeks later.[17] The 'three tube test' (a decrease in red cells in consecutive tubes) is notoriously unreliable. A false-positive diagnosis of subarachnoid haemorrhage can be almost as dangerous and fraught as a missed one. Spinning down the CSF should be done immediately, otherwise oxyhaemoglobin will form *in vitro*. If the supernatant seems crystal-clear, the specimen should be stored in darkness until absence of blood pigments is confirmed by spectrophotometry.[16]

A ruptured 'berry' aneurysm is the most common cause of subarachnoid haemorrhage, and is found in 80-85% of cases.[18] The other possible causes have been listed in Table 2.

Ruptured aneurysm

Though some textbooks for medical students still refer to aneurysms of the cerebral vessels as being 'congenital', this is erroneous: they are not present at birth but develop during the course of life. Aneurysms are almost never found in neonates and they are also rare in children.[19] Moreover, in those exceptional childhood aneurysms, there is usually a specific underlying connective tissue condition associated with aneurysms (Table 3).

The aneurysms arise at sites of arterial branching, usually at the base of the brain, either at the circle of Willis itself or at a nearby secondary branching site. The proportion of patients with aneurysms increases with age, but the absolute frequencies heavily depend on the type of study. A systematic overview of published studies found that the prevalence was 0.4% in retrospective autopsy studies (95% confidence interval, 0.4%-0.5%), 3.6% (3.1-4.1) for prospective autopsy studies, 3.7% (3.0-4.4) in retrospective angiography studies, and 6.0% (5.3-6.8) in prospective angiography studies.[19] For adults without specific risk factors, the prevalence was 2.3% (1.7-3.1). Only 8% (5-11) of the aneurysms were larger than 10 mm in diameter.

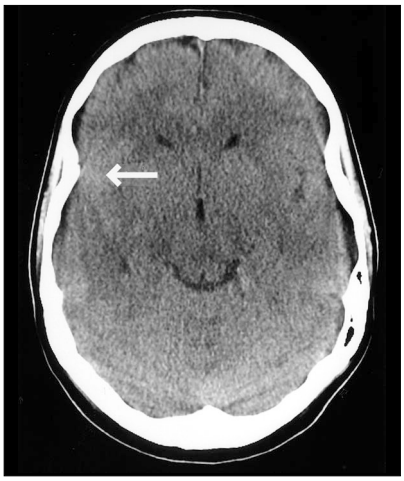


FIGURE 1A
CT scan of a patient with subarachnoid haemorrhage, performed within 12 hours of the onset of sudden headache. The right sylvian fissure (lateral part) shows slight hyperdensity (arrow).

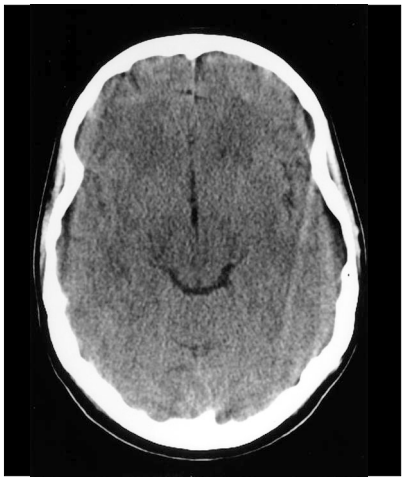


FIGURE 1B
CT scan of the same patient, made two days later. The subtle evidence of extravasation has now disappeared.

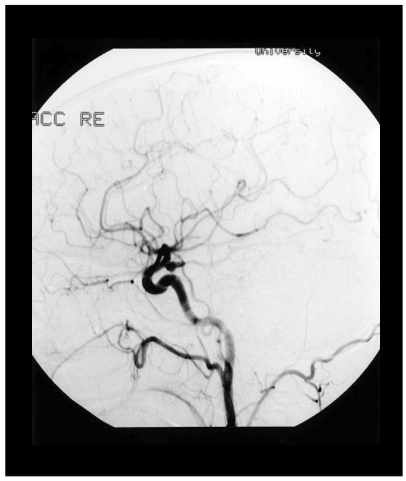


FIGURE 1C
Angiogram, showing aneurysm of the right middle cerebral artery.

TABLE 2
Causes of subarachnoid haemorrhage.

ruptured aneurysm	85%
non-aneurysmal perimesencephalic haemorrhage (of venous origin?)	10%
rarities • arterial dissection (transmural) • arteriovenous malformation • pituitary apoplexy • mycotic aneurysm • trauma (without contusion) • cocaine abuse	5%

TABLE 3
Conditions associated with ruptured aneurysms.

disorders of connective tissue
Marfan's syndrome
Ehlers-Danlos syndrome type IV
collagen type III deficiency
pseudoxanthoma elasticum
α_1-antitrypsin deficiency
neurofibromatosis
disorders of angiogenesis
hereditary haemorrhagic teleangiectasia
associated hypertension
coarctation of the aorta
polycystic kidney disease*
haemodynamic stress
anomalies of the circle of Willis
arteriovenous malformations
moya-moya syndrome

*In polycystic kidney disease not only hypertension but also developmental factors contribute to the development of intracranial aneurysms.

The overall risk of rupture per year was 1.9% (1.5-2.4); it was higher in women (RR, 2.1[1.1-3.9]), and for aneurysms that were symptomatic (RR, 8.3 [4.0-17]), >10 mm (RR, 5.5 [3.3-9.4]), or in the posterior portion of the cerebral arterial vasculature (RR, 4.1 [1.5-11]). It may well be that future studies will show smaller risks, as the increasing sensitivity of neuro-imaging methods will lead to the detection of smaller and smaller aneurysms.

Despite aneurysms not being congenital in the strict sense, there is some degree of genetic predisposition for their formation. It is well known that there are families in which three or more first- or second-degree relatives have suffered an episode of subarachnoid haemorrhage, and at a younger median age than the early fifties, which is the most common age at which sporadic aneurysms rupture.[20,21] Yet such families with at least three affected members form only a minute fraction of all subarachnoid haemorrhages, even though there must be many more than the published number of 50 families.[22] In so-called 'sporadic' cases with ruptured aneurysms, first-degree relatives have a rate of subarachnoid haemorrhage that is three to seven times higher than in second-degree relatives.[23]

Some classical risk factors for stroke in general also apply to the risk of subarachnoid haemorrhage. A systematic overview of methodologically-sound studies found that only smoking, hypertension and heavy drinking emerged as significant risk factors, with odds ratios in the order of two to three.[24] The risk was not significantly increased with use of oral contraceptives, hormone replacement therapy, or an increased level of blood cholesterol. Seasonal variation does not seem to occur.[25]

'Sentinel headaches', i.e. previous episodes of sudden-onset headache, are generally believed to be common in patients with aneurysmal subarachnoid haemorrhage and are attributed to a 'warning leak'. Indeed, on specific questioning, many patients do recall a previous episode of headache that was unusually severe and lasted several hours. Many neurosurgeons and neurologists are therefore convinced that important advances in the overall management of aneurysmal subarachnoid haemorrhage can be expected from early recognition of rupture on the very first occasion, followed by emergency clipping of the aneurysm. A major difficulty with the notion of these 'warning leaks' is that almost all studies have been hospital-based, most have been retrospective, and even prospectively-conducted studies are probably biased by hindsight (recall bias). In a prospective study of 148 patients with sudden, severe headache identified in general practice, 37 had subarachnoid haemorrhage; only two of these 37 patients had had previous episodes of sudden headache on systematic questioning by the general practitioner at the time of presentation for the headache.[5] Also, the amount and distribution of extravasated blood on brain CT was similar to that in a previous hospital series of patients with subarachnoid haemorrhage; the same applied to the overall outcome. In brief, the notion of frequent 'warning leaks' was not supported by the epidemiological, clinical and radiological findings from this study in the community.[5]

Non-aneurysmal perimesencephalic haemorrhage (Figure 2)
In this radiologically distinct and strikingly harmless variety of subarachnoid haemorrhage, the extravasated blood is confined to the cisterns around the mid-brain, and the centre of the bleeding is mostly immediately anterior to the mid-brain.[26-28] There is no extension of the haemorrhage to the lateral Sylvian fissures or to the anterior part of the interhemispheric fissure. Some sedimentation of blood in the posterior horns of the lateral ventricles may occur, but frank intraventricular haemorrhage or extension of the haemorrhage into the brain parenchyma rules out this particular condition.[27] In some cases the only evidence of blood is found anterior to the pons; this has prompted some to propose the term 'pretruncal haemorrhage'.[29] Yet in other exceptional patients, the blood is found only in the quadrigeminal cistern.[26,30] Cerebral angiography should still be considered because some aneurysms of the posterior circulation show the same pattern of haemorrhage.[26,27,31] This will probably be replaced soon by angiographic imaging obtained with spiral CT.[32]

Perimesencephalic haemorrhage constitutes approximately 10% of all first episodes of subarachnoid haemorrhage, and two-thirds of those with a normal angiogram.[27,33-36] It can occur in any patient over the age of 20 years, but most patients are in their sixth decade, as with aneurysmal haemorrhage. In one third of the patients,

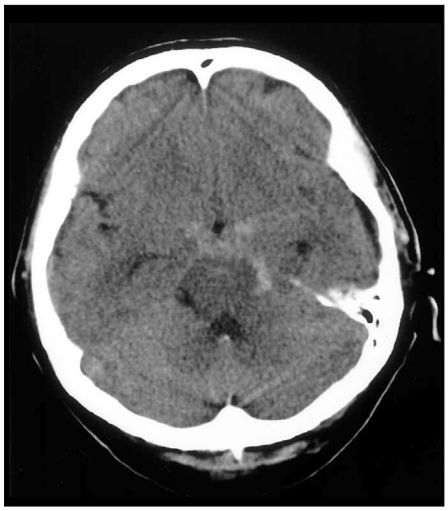


FIGURE 2
Non-aneurysmal perimesencephalic haemorrhage.

strenuous activities immediately precede the onset of symptoms,[37] a proportion similar to that found in aneurysmal haemorrhage.[26] The clinical features at onset may be milder than those in patients with aneurysmal rupture: the onset of the headache is gradual (minutes rather than seconds in a quarter of the patients), loss of consciousness is exceptional, and focal neurological abnormalities are not observed. On admission, all patients are in fact clinically normal, apart from their headache.[26,37] Typically, the early course is uneventful: rebleeds and delayed cerebral ischaemia simply do not occur. Although 20% of patients show acute hydrocephalus on their admission CT scan, only few have symptoms from it and this is mostly transient amnesia.[38] Even if surgical intervention is needed for progressive hydrocephalus, an excellent outcome can be anticipated.[39] The period of convalescence is short, and almost invariably patients are able to resume their previous work and other activities.[40,41] Rebleeds after the hospital period have not been documented.[42,43]

For the time being, the definition of this mild variant of subarachnoid haemorrhage remains a purely descriptive one, because post-mortem studies are not available, and because there is no single test which allows separation from related conditions. Yet, the milder clinical features, the limited extension of the extravasated blood on brain CT and the normal angiograms in a large series of patients with this pattern of haemorrhage are all evidence against an aneurysm or, in fact, any other arterial source of bleeding. Instead, rupture of a vein or a venous malformation in the interpeduncular, ambient or pre-pontine cistern appears to be a reasonable hypothesis.

Transmural dissection of an intracranial artery

Dissection in general tends to be recognised more often in the carotid artery than in the vertebral artery (see below), but subarachnoid haemorrhage from a wall dissection is found most often in the vertebral artery,[18,44] and exceptionally in the basilar artery or major branches of the internal carotid artery. Blunt rotational or hyperextension trauma, even if slight, is a common cause of vertebral artery dissection, particularly in the young. In an autopsy study of fatal episodes of subarachnoid haemorrhage, dissection was found in five of 110 patients.[45] Vertebral artery dissection in general results from an injury to the vessel, most often in its extracranial course.[46] The plane of cleavage in patients with subarachnoid haemorrhage is subadventitial rather than subintimal, and extends from the extracranial segment to the intradural portion, where the rupture occurs because there the outer wall of the artery is no longer protected by an external elastic lamina, while the adventitial layer is thinner than in the extradural portion.[47]

Neurological deficits that may accompany subarachnoid haemorrhage from vertebral artery dissection are palsies of the IXth and Xth cranial nerves, by subadventitial expansion,[48] or Wallenberg's syndrome, partial or complete, resulting from impairment of blood flow in the territory of the posterior inferior cerebellar artery with ischaemia of the dorsolateral medulla.[47] Rebleeds are common (30%-70% in different series), after an interval of as short as a few hours or as long as a few weeks; recurrent events are fatal in approximately 50% of the patients.[47,49-51]

Dissection of the intracranial portion of the internal carotid artery or one of its branches as a cause of subarachnoid haemorrhage is extremely uncommon - much less common than dissection of the internal carotid artery in the neck, a condition encountered several times per year in most neurology services of major teaching hospitals. Reported cases have affected the terminal portion of the internal carotid artery,[52] the middle cerebral artery,[53] and the anterior cerebral artery.[54]

Arteriovenous malformation

Cerebral arteriovenous malformations (AVMs) were formerly believed to cause a substantial proportion of subarachnoid haemorrhages, but since the advent of CT it has become clear that haemorrhages from AVMs almost invariably involve the brain parenchyma. Subarachnoid bleeding at the convexity of the brain may result from superficial AVMs, but only in less than 5% of all ruptured AVMs is no intercurrent intracerebral haematoma present.[55] Saccular aneurysms form on the 'feeding' arteries of 10-20% of arteriovenous malformations, because of the greatly increased flow and the attendant strain on the arterial wall. If bleeding occurs in these cases, it is more often from the aneurysm than from the malformation; once again the haemorrhage is in the brain itself rather than in the subarachnoid space.[56,57]

Dural AVMs of the tentorium can give rise to a basal haemorrhage that is indistinguishable on CT from aneurysmal haemorrhage.[58] Such an anomaly is rare and can be found from adolescence up to old age. Rebleeding may occur in patients with dural AVMs; in a series of five patients presenting with subarachnoid haemorrhage, three had one or more rebleeds.[59]

Pituitary apoplexy

The precipitating event of arterial haemorrhage occurring in a pituitary tumour (pituitary apoplexy) is thought to be tissue necrosis, involving the territory of one of the hypophyseal arteries. The initial features are a sudden and severe headache, followed by nausea, vomiting, neck stiffness, and sometimes a depressed level of consciousness.[60] The hallmark of pituitary apoplexy is that most patients suffer a sudden decrease in visual acuity: in one series of 15 patients, only two had normal visual acuity.[61,62] The combination of sudden, severe headache and decreased

vision (literally a 'blinding headache') may also occur in patients in whom rupture of an aneurysm is complicated by subhyaloid haemorrhages, but in most patients with pituitary apoplexy, eye movements are disturbed as well, because the haemorrhage compresses the oculomotor, trochlear and abducens nerves in the adjacent cavernous sinus.[61] CT and MRI scanning will demonstrate that the pituitary fossa is the source of the haemorrhage; in most instances the pituitary adenoma itself is visible.[61]

Mycotic aneurysm

Aneurysms associated with infective endocarditis (mycotic) are most often located on distal branches of the middle cerebral artery, but approximately 10% of the aneurysms develop at more proximal sites.[63] Therefore rupture of a mycotic aneurysm causes an intracerebral haematoma in most patients, but some have a basal pattern of haemorrhage on CT that is very similar to that of a ruptured saccular aneurysm. CT-documented rebleeds have been reported.[64] These patients present with clinical features of infected heart valves before subarachnoid haemorrhage occurs, but occasionally rupture of a mycotic aneurysm can be the initial manifestation of infective endocarditis.[65,66]

Mycotic aneurysms in patients with aspergillosis are usually located on the proximal part of the basilar or carotid artery.[67] Rupture of such an aneurysm causes a massive subarachnoid haemorrhage in the basal cisterns, indistinguishable from that of a saccular aneurysm.[68] Aspergillosis is difficult to diagnose but should particularly be suspected in patients undergoing long-term treatment with antibiotics or immunosuppressive agents. Most patients with haematogenous dissemination have pulmonary lesions, but X-ray films of the chest may be normal early in the course.[68,69]

Trauma

In some patients with trauma and subarachnoid haemorrhage it may be extremely difficult - though of vital forensic importance - to find out which occurred first. Patients may be found alone having been beaten up in a brawl or hit in the course of a vehicular collision, without external wounds to indicate an accident, with a decreased level of consciousness making it impossible to obtain a history, and with neck stiffness causing the patient to be investigated clinically for subarachnoid haemorrhage. Conversely, patients with aneurysmal rupture while riding a bicycle or driving a vehicle may cause a traffic accident and, in really complicated situations, may even sustain a skull fracture, which causes them to end up in hospital with a diagnosis of head injury.[70] Thus a meticulous reconstruction of traffic accidents is especially indicated in patients with disproportionate headache or neck stiffness. Brain CT may also help. If trauma is the cause of subarachnoid haemorrhage, the blood is usually located in the superficial sulci at the convexity of the brain, adjacent to a fracture or to an intracerebral contusion, which anatomical findings can help to dispel any lingering concern about the possibility of a ruptured aneurysm. In patients with basal-frontal contusions, however, the pattern of haemorrhage can resemble that of a ruptured aneurysm of the anterior communicating artery, and in patients with blood confined to the sylvian fissure, it may also be difficult to distinguish trauma from aneurysmal rupture by the pattern of haemorrhage alone. In patients with direct trauma to the neck or with head injury associated with vigorous neck movement, the trauma can immediately be followed by massive basal haemorrhage resulting from a tear or even a complete rupture of one of the arteries of the posterior part of the cerebral circulation, an event that often is rapidly fatal.[71,72]

Cocaine abuse

In patients with subarachnoid haemorrhage related to the use of the alkaloid form of cocaine, 50% have no aneurysm on the angiogram.[73] The pattern of haemorrhage on brain CT may be comparable to that of a ruptured saccular aneurysm,[74] and the diagnosis rests on a confirmatory history or on the results of toxicologic tests. Rebleeds do occur, even in patients with a normal angiogram, and outcome is often poor.[75]

The source of the haemorrhage in patients without an aneurysm is unknown. Although biopsy-proven vasculitis has been found in patients with cocaine abuse,[76] changes which could be suggestive of vasculitis often fail to show up on angiograms - admittedly a very insensitive test.[73,75]

PRIMARY INTRAVENTRICULAR HAEMORRHAGE

Intraventricular haemorrhage is usually associated with either subarachnoid haemorrhage from a ruptured aneurysm (most often at the anterior communicating artery complex) or intracerebral haemorrhage. In both conditions, the outcome is worse with intraventricular rupture than without,[77,78] and an intraventricular blood volume of more than 20 ml is invariably fatal.[79,80] In contrast, the outcome of 'primary' intraventricular haemorrhage, without detectable cause, is much better than if it is associated with subarachnoid or intra-parenchymal haemorrhage,[81] and patients may survive with intraventricular haemorrhages far exceeding 20 ml.[80] The advent of CT proved that intraventricular haemorrhage is not the invariably lethal condition it was once thought to be, when the diagnosis was made only in those who died.

Idiopathic intraventricular haemorrhage is often speculatively attributed to occult arteriovenous malformations in the ependymal wall, because sometimes this can be actually demonstrated.[82] Other specific causes may be found in exceptional cases, ranging from tumours that are immediately obvious on CT scanning to small aneurysms at uncommon sites, which only assiduous investigation can uncover.

INTRACEREBRAL OR CEREBELLAR HAEMORRHAGE

More than 50% of patients with primary intraparenchymal haemorrhage have headache at onset, especially with superficial haemorrhages.[83] Therefore superficial (lobar) types of primary intracerebral haemorrhage, and more so cerebellar haemorrhage, may be confused with subarachnoid haemorrhage, because of the prominent headache, and also because focal deficits are less prominent than with deep haematomas. Conversely, 20-50% of aneurysmal haemorrhages are associated with an intracerebral haematoma (the proportion depending on definitions), though mostly in locations not likely to produce focal deficits (the frontal lobe, the medial part of the temporal lobe, and the structures surrounding the Sylvian fissure).[84,85] Primary intracerebral haemorrhage is mostly caused by rupture of a small perforating vessel; as these intracerebral haematomas are often situated

closely to the internal capsule or other parts of the corticospinal system,[86] they typically result in a dense hemiplegia.

In a consecutive series of 100 patients with an initial diagnosis of subarachnoid haemorrhage reported in 1980, eight had a cerebellar haematoma (95% confidence interval 4-16%), whereas seven had primary brain haemorrhages in the supratentorial space.[84] If vomiting rather than headache is the most prominent clinical feature, even the neurological origin of the disorder may at first go unrecognised. In general, patients with cerebellar haematomas may eventually have remarkably few sequelae, even after surgical resection; in a deteriorating patient drainage of cerebrospinal fluid via an external ventricular catheter may suffice if clinical features indicate that the haematoma compresses only the fourth ventricle and not the brain stem.[87]

SUBDURAL HAEMATOMA

Subdural haematomas without attendant haemorrhage in the subarachnoid space or in the brain parenchyma are traditionally associated with trauma, but they may also occur 'spontaneously' (or, one might speculate, with trauma that is too slight to be remembered). Anticoagulant treatment is the most common precipitant, in urbanised areas of Western Europe accounting for approximately one quarter of all subdural haematomas and half of those without obvious trauma.[88] In anticoagulant-associated subdural haematoma the onset may be very acute, with headache alone or a rapidly decreasing level of consciousness; the outcome may be lethal.[89] Rapid correction of the coagulation status is mandatory, usually followed by craniotomy. A ruptured small pial artery is probably the next common cause, and sometimes angiography shows the extravasation from a small artery at the surface of the brain into the subdural space.[90]

If the level of consciousness remains normal, spontaneous resolution may occur, even with an acute onset.[91,92] On the other hand, patients in whom the onset of symptoms is measured in days or weeks, the haematoma presumably originating from a bridging vein,[89] may rather suddenly deteriorate.[93] Even chronic subdural haematomas may present with acute headache, mimicking subarachnoid haemorrhage.[94] Most spontaneous subdural haematomas occur over the convexity of the cerebral hemisphere, but they may also be found in the interhemispheric fissure or in the posterior fossa.[95]

A subdural haematoma may also occur together with an intraparenchymal haematoma, from degenerative arteriolar disease,[96,97] or an arteriovenous malformation,[98] or in association with a ruptured aneurysm.[99,100]

OTHER SERIOUS NEUROLOGICAL CONDITIONS

Intracranial venous thrombosis

Sudden headache may be a presenting feature in this condition, in as many as 10 out of 71 patients in a study specifically dedicated to the subject.[101] In all ten patients who presented with sudden headache, the characteristics of the headache and the clinical signs and symptoms were clinically indistinguishable from those of subarachnoid haemorrhage. Computed tomography scans on admission were initially interpreted as normal in five patients (one with single-dose contrast), as subarachnoid haemorrhage in three, and as multiple intracranial haemorrhages in the remaining patients. The cause of sudden headaches in patients without haematomas is a matter for speculation.

Cerebral venous thrombosis is typically a disease of young women.[102] The number of factors implicated in its pathogenesis is virtually unlimited, but prominent among these are dehydration, parturition, use of oral contraceptives (especially with those of the third generation)[103] and thrombophilia, for example resulting from the Leiden V mutation.[104,105] Apart from sudden headache the presenting features may consist of gradually-developing headaches (when the thrombotic process is limited to part of the superior sagittal sinus and increased pressure of the cerebrospinal fluid is the only pathophysiological disturbance), or of focal neurological deficits and seizures, as a result of venous infarction (bland or haemorrhagic). The haematomas appear near the convexity of the brain, adjoining the dural sinuses or the cortical veins that drain on these (Figure 3).[106] This is quite unlike the haematomas associated with ruptured aneurysms, which are located at the base of the brain, near the circle of Willis.

Arterial dissection (intramural)

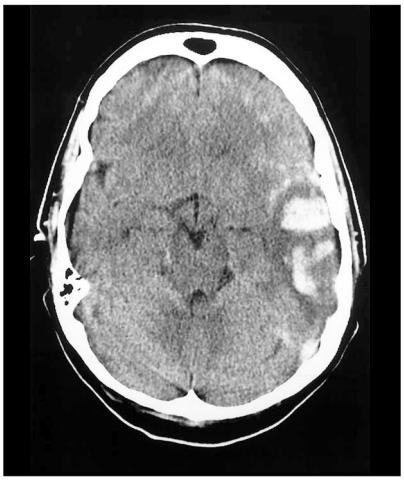
Cervical arterial dissection may follow blunt injury to the neck, or it coincides with an apparently trivial neck movement or a fit of coughing, but it can be truly spontaneous.[107] In a minority of patients in this last group there are detectable disorders of the arterial wall, such as fibromuscular dysplasia, Marfan's syndrome, cystic medial necrosis, or less defined disorders of collagen.[108,109] It occurs in all age groups.[110] The internal carotid artery is most often affected, the lesion typically beginning a few centimetres distally from the bifurcation; if dissection involves the vertebral artery it is often associated with rotational or hyperextension injury.

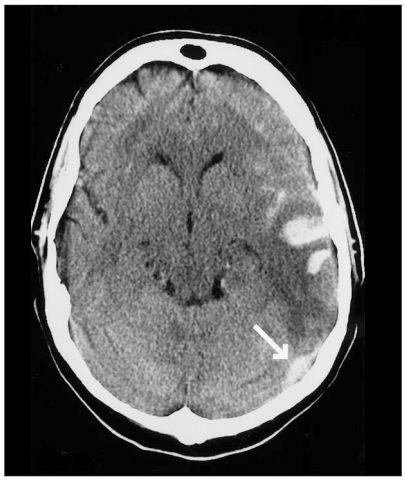
Blood enters into and splits the arterial wall to form an intramural haematoma of variable length. Pain receptors in the wall of the artery may cause moderate to severe pain in one side of the face, around the eye, in the neck or at the side of the head with dissection of the internal carotid artery, or in the back of the head or the neck for vertebral dissection.[111]

If neurological deficits develop, these may coincide with the headache or follow after an interval of hours to days.[107] When the false lumen forms in the outer part of the arterial wall, the adventitial layer will bulge. In case of the internal carotid artery, this may lead to compression of adjoining structures: the oculo-sympathetic plexus, and cranial nerves IX-XII.[112,113] If the blood tracks under the intima rather than under the adventitial layer, the intimal flap may occlude the arterial lumen. Ischaemic stroke is reported in 10-50% of all patients (depending on the level of suspicion in mild cases); it results from poor collateral circulation or secondary thromboembolism.[114]

Colloid cyst of the third ventricle

Paroxysmal severe headache may be a manifestation of a colloid cyst of the third ventricle moving in and out of the foramen of Monro on its pedicle with intermittent obstruction of CSF.[115] The headaches may be triggered by head movements, but this occurs in only a minority.[116] Often the headache is accompanied not only by nausea and vomiting but also by a deterioration in the level of consciousness. The outcome may be rapidly fatal, the clinical course resembling that of intracranial





FIGURES 3A AND 3B
CT scan of a patient with cerebral venous thrombosis, who had presented with sudden headache. Haematoma in the left temporal lobe, with a ragged shape that is compatible with venous infarction. Part of the left transverse sinus is hyperdense (arrow).

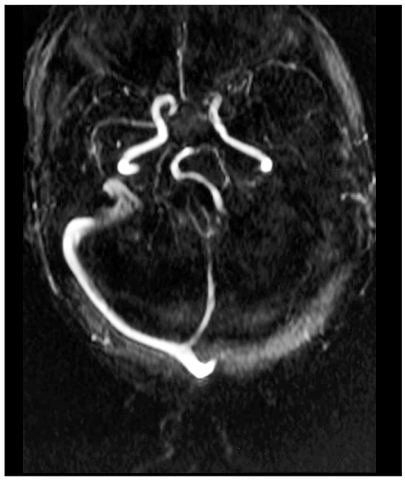


FIGURE 3C
Magnetic resonance venography, showing non-filling of the left transverse sinus.

haemorrhage.[117]

Meningitis and other inflammatory disorders
The onset of headache in patients with bacterial or viral meningitis is typically gradual, yet occasionally it is reported as sudden.[5] We do not know how accurate the history actually is in those cases, but the problem remains that the odd patient referred with a possible episode of subarachnoid haemorrhage turns out to have meningitis. This consideration is another reason to examine the cerebrospinal fluid if CT scanning is negative.

Sinusitis may also cause the development of a headache within seconds, especially with air travel, if the cabin pressure changes abruptly. The typical frontal location of the headache, and the associated symptoms and signs will rapidly lead to the diagnosis.

FUNCTIONAL HEADACHE SYNDROMES

Certain types of innocuous headache may come on within a split second and be very severe, a combination that is often alarming. The distinction from subarachnoid haemorrhage is often impossible without investigations, except in a few characteristic syndromes delineated below.

Idiopathic 'thunderclap' headache
This type of headache is typically uncharacteristic, without specific circumstances or clinical features that allow the clinician to rule out a ruptured aneurysm without recourse to brain CT and lumbar puncture. This is the largest subgroup of those with functional syndromes, about 70%.[118] About 50% of these patients have a history of typical migraine or tension-type headache (with gradual onset) and many others develop either condition later on.[118]

Benign exertional headache
This type of headache develops during or immediately after physical exertion. The pain is throbbing, is often associated with nausea, vomiting and photophobia, and lasts a couple of hours.[119] It affects all age groups. Its onset may be predictable, as in a female student who could not play a full match of field hockey without an attack soon afterwards. Frequently there is a history of spontaneous migrainous attacks in the patients themselves or in close relatives. The same type of headache may occur at high altitude.

Venous strain headache
'Cough headache' was the name coined for this condition by Symonds in 1956,[120] but it may also follow sneezing, bearing down, lifting heavy weights, laughing or stooping. The headache begins in the neck or behind the eye, and from there radiates to other parts of the skull; it lasts a few hours. Mostly men are affected (sex ratio 5:1), typically 50-60 years of age. The pain probably results from distension of intracranial venous structures, through excitation of pain receptors in the wall. Imaging of the posterior fossa is often indicated, because sometimes there is an underlying structural lesion such as a cerebellar tumour or tonsillar ectopia.[119,121]

Headache related to sexual activity
Mostly men are affected (sex ratio 4:1), at any age in adulthood, usually for a couple of months only, after which the attacks subside spontaneously.[122] There are two main subtypes. The vascular form is characterised by throbbing, explosive headache with an onset shortly before or during orgasm, lasting for minutes or hours, and associated with nausea, vomiting and photophobia. About 25% of patients have had previous attacks of classical migraine.[122,123] The muscle contraction type develops in the earlier stages of sexual excitement and is characterised by a gradual tightness, radiating forwards from the back of the head.[122] A much more exceptional type of orgasmic headache is related to the vertical position and has been attributed to sudden leakage of cerebrospinal fluid, comparable to headache after lumbar puncture.[124]

'Icepick' headache
This term has been coined for brief, jabbing pains mostly at the temples or orbits but on occasion elsewhere in the head.[125] Migraineurs are especially susceptible (in a

systematic study half of them had them at least monthly, and in more than half they occurred concurrently with migraine attacks).[125] Precipitants may be postural change, physical exercise, or head motion.

'Exploding head' syndrome

A sensation not so much of pain but rather of sudden noise and terror may strike subjects over the age of 50, men and women alike, especially during the twilight of sleep.[126] The attacks occur in clusters.

SUMMARY

In summary, the great majority of headache attacks with sudden onset are benign in nature (two thirds in general practice, one fourth in hospital series). Most of those (70%) are 'idiopathic thunderclap headaches', probably variants of migraine or muscle contraction headache. This large proportion reflects the epidemiological principle that rare variants of common conditions often outnumber uncommon conditions. Unless a characteristic type of benign functional headache can be recognised, hospital referral and investigations are necessary to rule out a ruptured intracranial aneurysm, other intracranial haemorrhage, or other serious brain disease. Such an approach serves the patient's best interests and is also cost-effective.[127]

Key points in the diagnosis of subarachnoid haemorrhage:

- **Headache is very common in general practice, but thunderclap headache is not.**
- **One out of every four patients with sudden, severe headache has a ruptured cerebral aneurysm, or one out of eight if headache is the only symptom.**
- **No physical sign can exclude SAH if the headache persists for a few hours.**
- **Computed tomography misses 2% of aneurysms after recent (< 12 hours) rupture.**
- **Lumbar puncture should be done after a negative scan but not until 12 hours after onset.**
- **Blood-stained CSF should be immediately centrifuged; if the supernatant is yellow this proves haemorrhage.**

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