

## NOSOLOGICAL ENTITIES?

# Thunderclap headache

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*J Neurol Neurosurg Psychiatry* 2002;**72**:6–11

The aim is to review the background underlying the debate related to the alternative nomenclatures for and the most appropriate diagnostic evaluation of patients with thunderclap headache. The clinical profile and differential diagnosis of thunderclap headache is described, and a nosological framework and diagnostic approach to this group of patients is proposed.

**T**hunderclap headache refers to a severe and explosive headache with peak intensity at onset—as sudden and as unexpected as a “clap of thunder”. The term was first used to describe this type of headache as a presentation of an unruptured cerebral aneurysm.<sup>1</sup> Whether unruptured aneurysms in this and other cases are incidental findings has become a problematic issue and considerable debate has ensued regarding the nomenclature of this term and the most appropriate diagnostic evaluation of patients presenting with thunderclap headache. To add further complexity, since its introduction, the term has also been used to refer to an idiopathic benign recurrent headache disorder, a variant of migraine, and a presenting symptom of various sinister underlying causes including subarachnoid haemorrhage, cerebral venous sinus thrombosis, pituitary apoplexy, spontaneous intracranial hypotension, and hypertensive encephalopathy.<sup>2–6</sup> The purpose of this discussion is to review the background underlying this debate, to describe the clinical profile and differential diagnosis of thunderclap headache, and to propose a nosological framework and diagnostic approach to this group of patients.

### CAN UNRUPTURED INTRACRANIAL ANEURYSMS PRESENT WITH THUNDERCLAP HEADACHE?

An instantaneous severe headache has long been recognised as the signature feature of aneurysmal subarachnoid haemorrhage, but some 20%–50% of patients report a distinctive and unusually severe headache in the days or weeks preceding such a haemorrhage. This headache is often referred to as a *warning* or *sentinel* headache<sup>7–10</sup> and has often been thought to represent a “warning leak” or small subarachnoid haemorrhage. A recent study has cast some doubt on this hypothesis by demonstrating a frequency of severe headache in only 11% of patients in the 1 month preceding a subarachnoid haemorrhage.<sup>11</sup> The authors suggested the possibility that in the context of serious brain disease, the severity of a prior headache episode is overinterpreted (recall bias) and this may account for the higher frequency of sentinel headaches in other studies.

In 1986, the term thunderclap headache was introduced to describe a similar headache as a presenting feature of an unruptured cerebral aneurysm.<sup>1</sup> The authors described a 42 year old woman who had three severe acute headaches within 1 week. The CT brain and CSF examinations were normal. Despite the absence of blood within the CSF, conventional angiography showed diffuse, multifocal, and segmental cerebral vasospasm and a saccular aneurysm at the point of origin of the right posterior cerebral artery. However, no evidence of old or recent haemorrhage was seen during aneurysmal surgery. Four weeks later, the follow up angiogram was normal. The authors concluded that unruptured intracranial aneurysms can present with “thunderclap headache” and cerebral angiography is necessary in these patients even when the CT and CSF are normal.

A very similar case was reported 2 years later—a 50 year old woman had recurrent thunderclap headaches within a 13 day period without evidence of blood on either the CT or CSF.<sup>12</sup> Angiography disclosed a 4 mm wide neck aneurysm of the internal carotid artery (ICA) with evidence of vasospasm in the right ICA and both middle cerebral arteries, but at surgery, there was no evidence of rupture. More recently, a 50 year old woman who had a thunderclap headache and a normal CT and CSF in the setting of a posterior communicating artery aneurysm (with daughter sac) was reported.<sup>13</sup> At surgery, although the aneurysm dome was said to have been “thin walled”, there was no evidence of haemorrhage or rupture.

In the light of the 3.6%–6% prevalence of unruptured intracranial aneurysms in the general population,<sup>14</sup> these cases have sparked and fuelled the debate over whether the aneurysm in each case was an incidental finding or whether an unruptured saccular aneurysm can present with thunderclap headache and a normal CT, CSF, and neurological examination.<sup>15 16</sup> In view of the fact that about 12% of patients with subarachnoid haemorrhage present with the “worst headache of their life” and a normal neurological examination, this issue takes on singular importance.<sup>7</sup> The answer to this question of course would answer the pressing question as to whether any or all such patients should undergo conventional angiography.

The most compelling evidence which supports the view that thunderclap headache may be symptomatic of an unruptured aneurysm was a

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Received  
8 January 2001  
In final revised form 29  
August 2001  
Accepted 19 September  
2001

**Abbreviations:** CVST, cerebral venous sinus thrombosis; SIH, spontaneous intracranial hypotension; MRA, magnetic resonance angiography; CTA, CT angiography

report of a 53 year old woman whose CT and CSF were normal after presenting with a sudden severe headache.<sup>17</sup> Two days later, the patient was found unresponsive and died shortly after an angiogram disclosed a right internal carotid aneurysm. Unfortunately, this case was only presented as an abstract, and neither the cause of death nor evidence of subarachnoid haemorrhage was disclosed.

In one retrospective series, 7/111 patients with symptomatic unruptured saccular aneurysms were said to have presented with thunderclap headache.<sup>18</sup> Unfortunately, not all patients in this study had CSF examinations and there were abnormal neurological findings or other clinical and imaging features which posed little diagnostic confusion as to the presence of an underlying cause for the headache. This study therefore did not address patients with thunderclap headache with normal CT, CSF, and neurological examinations.

In another retrospective series, 562 patients presented with sudden severe headache, normal CT, and “colourless” CSF.<sup>19</sup> Cerebral aneurysms were found in 52 patients (9.3%). Of the 46 patients who were taken to surgery, eight (1.4%) had a “minor leak”, although it is unclear exactly how this was determined.

Collectively, these data have prompted the recommendation that because of the potentially devastating consequences of overlooking a symptomatic saccular aneurysm, angiography should be obtained in patients with thunderclap headache and normal CT, CSF, and neurological examinations.

“Thunderclap headache is a clinical emergency which mandates a swift evaluation with investigations aimed at excluding a subarachnoid haemorrhage”

Evidence against an association between unruptured intracranial aneurysms and thunderclap headache on the other hand is derived from several prospective studies which have concluded that in patients with thunderclap headache and a bloodless CT and CSF, angiography is not indicated.<sup>20–24</sup> In one prospective series, 71 patients with thunderclap headache and negative CT and CSF examinations were followed up for a mean of 3.3 years.<sup>20</sup> None of these patients had a subarachnoid haemorrhage during the follow up period although 27% of these patients had experienced similar headaches either before or subsequent to the index event. Similarly, other studies have reported recurrent thunderclap headaches in 8%–44% of patients after the first presentation,<sup>21–24</sup> suggesting that thunderclap headache may be a unique and recurrent, but benign, primary headache disorder.

Thus, the overwhelming majority of patients who present with thunderclap headache and have normal CT and CSF examinations, will not harbour a *symptomatic* cerebral aneurysm, and in the absence of other intracranial causes, the outcome and prognosis is benign. The question as to which patients require further investigation and which diagnostic studies to pursue depends on the clinical index of suspicion of other disorders which may present with thunderclap headache and normal neurological, CT, and CSF examinations.

### SYMPTOMATIC THUNDERCLAP HEADACHE

Although idiopathic thunderclap headache may represent a distinct primary headache syndrome, an indistinguishable headache profile may occur in the setting of sinister intracranial and extracranial vascular pathology. In addition to subarachnoid haemorrhage which is a well recognised cause for thunderclap headache, similar sudden peak intensity headaches with normal neurological examinations can be the presenting feature of cerebral venous sinus thrombosis (CVST), pituitary apoplexy, cervicocephalic arterial dissection, acute hypertensive crisis, and spontaneous intracranial hypotension.<sup>2–5</sup> These disorders, with the exception of subarachnoid haemorrhage, may often evade detection by CT and lumbar puncture.

Headache is the most common symptom of cerebral venous sinus thrombosis and occurs as the most frequent presenting symptom in about 75% of cases. The headache may be diffuse or localised, and it is most often persistent, worse upon recumbency, and aggravated by the Valsalva manoeuvre. Although its onset is usually subacute over several days, thunderclap headache may be the presenting feature in up to 10% of patients with CVST.<sup>25</sup> Overall, CT is interpreted as normal in about 25% of patients with CVST. This proportion reaches 50% or more in patients with isolated intracranial hypertension but is below 10% in patients with focal neurological signs.<sup>26–27</sup> Although some combination of lymphocytic pleocytosis, red blood cells, and increased protein is present in 30%–50% of published cases, up to 40% of patients with CVST may have raised opening pressure without alteration in cytochemistry studies.<sup>28–29</sup> When there is clinical suspicion of CVST, CT has now been supplanted by MRI, which should be the initial investigation.<sup>30</sup>

Headache is also the earliest and most common clinical manifestation of symptomatic internal carotid artery dissection, occurring in up to 75% of patients.<sup>31–33</sup> A syndrome of oculosympathetic paresis (Horner’s syndrome) and unilateral headache, especially in the anterior head region, is strongly suggestive of internal carotid artery dissection. Acute hemispheric headache with delayed focal cerebral ischaemic events is also a common presentation of internal carotid artery dissection. The mode of onset of headache is instantaneous and severe in about 13% of cases.<sup>32</sup> Unless accompanied by ischaemic stroke, CT and lumbar puncture is unrevealing and MR angiography is fast becoming the imaging modality of choice in demonstrating the arterial dissection. The outcome of internal carotid artery dissection is generally favourable, but permanent neurological deficits and even death may result.<sup>32–34</sup> Although no controlled trials are available, early identification of arterial dissection may allow early initiation of antiplatelet or anticoagulation therapy, possibly preventing a more serious cerebral ischaemic complication.

A recent study of 28 consecutive patients with spontaneous intracranial hypotension (SIH) secondary to spinal CSF leaks found that four of the 28 patients (14%) presented with thunderclap headache.<sup>5</sup> Nuchal rigidity was present in three patients who sought early medical attention. These patients underwent CT, lumbar puncture, and cerebral angiography to exclude an aneurysmal subarachnoid haemorrhage. Despite the negative results on these initial studies, all patients had evidence of brain and/or cerebellar tonsillar descent, and pachymeningeal thickening and enhancement, which are characteristic findings of this syndrome on MRI.

Finally, pituitary apoplexy has been reported to present with thunderclap headache in the absence of positive findings on clinical, CT, and/or CSF examinations.<sup>2–6</sup> Pituitary apoplexy is an uncommon clinical syndrome usually characterised by acute headache, ophthalmoplegia, diminished visual acuity, and altered mental status caused by the sudden infarction or haemorrhage of a pituitary gland that invariably harbours an adenoma. The clinical manifestations of pituitary apoplexy however are protean, ranging from a clinically benign event to a catastrophic illness with adrenal crisis, coma, or sudden death. These cases illustrated the fact that the pituitary tumour, which is isodense to brain tissue, can easily be overlooked on routine CT, even when haemorrhage is present within the gland. Brain MRI readily identifies both the tumour and the associated haemorrhage. These cases emphasise the importance of considering this potentially devastating disorder as a cause of thunderclap headache, particularly when initial investigations seem unrevealing and underscore the value of MRI in detecting underlying causes for thunderclap headache, which may not be obvious on the initial CT or lumbar puncture.

### Diagnostic criteria for idiopathic thunderclap headache

- (1) Very severe pain intensity
- (2) Instantaneous or hyperacute onset of pain (<30 seconds)
- (3) Appropriate investigations exclude the presence of an underlying cause. These include subarachnoid haemorrhage, cerebral venous sinus thrombosis, pituitary apoplexy, arterial dissection, spontaneous intracranial hypotension, and acute hypertensive crisis.

#### Comment

Idiopathic thunderclap headaches may occur spontaneously or may be precipitated by the Valsalva manoeuvre, sexual activity, strenuous exercise, or exertion. Headaches may recur over a 7–14 day period. Similar headaches may occur infrequently over subsequent months to years. Investigations are always necessary to rule out secondary causes listed in 3. If performed, angiography may demonstrate diffuse segmental cerebral vasospasm, which resolves within weeks to months.

Modified from Dodick *et al.*<sup>15</sup> By permission of *Cephalalgia*.

### BENIGN (IDIOPATHIC) THUNDERCLAP HEADACHE

It is clear that in the absence of organic intracranial pathology, thunderclap headache may occur as a benign and potentially recurrent idiopathic headache disorder.<sup>15 20–24</sup> Before the introduction of the term in 1986, benign thunderclap headache has been referred to under various terms or clinical circumstances such as benign vascular headache, migrainous vasospasm, crash migraine, benign sexual (coital) headache type II, and benign isolated cerebral vasculitis or benign angiopathy of the nervous system.<sup>35–43</sup>

Although some patients with idiopathic thunderclap headache may have a history of migraine, the clinical presentation and temporal profile of thunderclap headache is distinctively unique. Indeed, a characteristic clinical and angiographic pattern has begun to emerge and diagnostic criteria have been proposed (box).<sup>15 44</sup> The headache, which is sudden and reaches maximum intensity within 30 seconds, usually lasts up to several hours, but a lingering less severe headache may persist for weeks. Episodes of thunderclap headache may occur repeatedly over a 7–14 day period. In up to one third of patients, the headache may recur over subsequent months to years.

From the available literature, it seems that idiopathic thunderclap headache may be associated with angiographic evidence of diffuse segmental vasospasm.<sup>15 41 44</sup> These headaches may occur spontaneously while at rest or during light activities, or may be precipitated by intense exertion, Valsalva manoeuvres, or sexual activity. Exercise, weight lifting, or sexual intercourse is a precipitating event in up to one third of patients with idiopathic thunderclap headache. In fact, benign sexual headache type II likely represents idiopathic thunderclap headache and reflects the influence of exertion on this headache disorder rather than having a unique relation to sexual activity itself.

Thunderclap headache which is associated with diffuse vasospasm in the absence of subarachnoid haemorrhage, may be associated with fluctuating focal neurological signs or symptoms, seizures, and even stroke.<sup>45 46</sup> Angiography demonstrates alternating segments of arterial constriction and dilatation involving large cerebral arteries at the circle of Willis and their second and third order branches. These cases, which occur in the absence of an obvious precipitating cause other than exertion, should be distinguished from what has been

termed “benign angiopathy of the CNS”. In these reported cases, some associations have been identified including the ingestion of ergotamine derivatives and the postpartum period (postpartum angiopathy), which has been related in some cases to bromocriptine.<sup>47 48</sup> As in the idiopathic cases, this disorder is often self limiting and resolves within 2 months without treatment. However, when cerebral vasospasm is present, careful clinical monitoring is important and although the evidence is purely anecdotal, nimodipine may be used in an attempt to prevent or ameliorate the risk of a delayed ischaemic deficit.<sup>45</sup>

Although these two entities may be synonymous, until more is known about their pathogenesis, idiopathic thunderclap headache should remain a separate disorder and the use of the term “angiopathy” should be avoided in cases of spontaneous thunderclap headache until such time as evidence of abnormal vascular histopathology is demonstrated.

Idiopathic thunderclap headache with vasospasm must also be distinguished from inflammatory CNS vasculitis, as the outcome, management, and prognosis are different. Isolated CNS vasculitis is not known to present with thunderclap headache in the absence of subarachnoid haemorrhage<sup>49</sup> and these patients often have abnormal CSF. Also, isolated CNS vasculitis is invariably restricted to blood vessels which are less than 0.5 mm in diameter and not, as reported in patients with thunderclap headache and vasospasm, in the large blood vessels that constitute the circle of Willis and their second order branches.

The striking similarity between the clinical presentation and angiographic features of idiopathic thunderclap headache with vasospasm and the reported cases of unruptured aneurysms presenting as thunderclap headache, strongly suggest that the unruptured aneurysms found in these cases were incidental and unrelated to either the headache or the vasospasm.<sup>1 12 13</sup> It would certainly be difficult to account for a mechanism by which an unruptured aneurysm could precipitate diffuse, segmental, cerebral vasospasm in the absence of subarachnoid blood.

### PATHOPHYSIOLOGY

The pathophysiology or mechanism(s) underlying idiopathic thunderclap headache with or without segmental vasospasm is unclear. The occurrence of the headache during physical activity, in patients with pheochromocytoma or acute hypertensive crises, and in patients who ingest sympathomimetic drugs or foods containing tyramine while concurrently using MAO inhibitors, suggests the possibility that excessive sympathetic activity or an abnormal vascular response to circulating catecholamines may be involved. In support of this hypothesis, as a radiographic entity, reversible cerebral vasospasm has also been associated with pheochromocytoma, eclampsia, and sympathomimetic (amphetamine, cocaine) drug intoxication.<sup>50–53</sup>

Vasospasm, as opposed to arterial stenosis, usually reflects a reversible process consisting of a localised smooth muscle contraction of the blood vessel wall, which results in segmental luminal narrowing. Vasospasm can be provoked by mechanical, biochemical, and neurogenic stimuli. The abrupt onset of both the headache and vasospasm would seem to imply a neurogenic mechanism. The perivascular and intramural portions of the intracranial arteries are richly invested with sympathetic nerves containing neuropeptide Y and in human cerebral and meningeal blood vessels, neuropeptide Y elicits concentration dependent contraction.<sup>54 55</sup> That vascular calibre may directly reflect sympathetic tone and sympathetic receptor sensitivity is evident from experimental and animal models of vasospasm in subarachnoid haemorrhage as well as the clinical finding of multifocal vasospasm in patients with pheochromocytoma and sympathomimetic drug intoxication.<sup>50 52 53 56 57</sup> It is possible therefore, that idiopathic

thunderclap headache represents a spontaneous and aberrant central sympathetic response. This is supported by the finding of sudden and severe headache in patients with paroxysmal hypertension due to baroreceptor dysfunction and loss of inhibition of central sympathetic reflexes.<sup>58</sup>

### THUNDERCLAP HEADACHE AND “CRASH MIGRAINE”

It has been suggested that idiopathic thunderclap headache is simply a migraine variant and may be a harbinger for future migraine attacks.<sup>20,38</sup> Indeed, in patients with a history of migraine, the occurrence of an unusual sudden severe headache which was self limited and accompanied by nausea and vomiting, was the basis for the use of the term “crash migraine”.<sup>38</sup> The original description of crash migraine bears a striking resemblance to idiopathic thunderclap headache—“This (crash migraine) refers to headache that “out of the blue” in 10 or 20 seconds reaches a high intensity, suggesting subarachnoid hemorrhage; yet, both lumbar puncture and angiography are normal. The headache may be situated posteriorly or generalized. Vomiting occurs in about one half of the cases. There may be a recurrence 2 or 3 days later. In some 10 patients, long-term follow-up has revealed no disaster”.

The clinical features, temporal pattern, mode of onset, and associated features of idiopathic thunderclap headache are not only unique, but quite distinct from the well established clinical criteria of migraine and tension type headache. The International Headache Society classification has established a uniform terminology for headache disorders where the diagnosis is based on clinical features.<sup>59</sup> By providing homogenous patient population samples, these criteria have facilitated an enormous advance in our knowledge of the epidemiology and pathophysiology of several primary headache disorders. This has led, and continues to lead, to remarkably effective treatments for some of these disorders.

To gain insights into the epidemiology, clinical range, pathophysiology, appropriate management, and prognosis of patients with this disorder, clinical criteria must be established to create homogenous patient populations to study in a prospective fashion. If idiopathic thunderclap headache were to be considered a migraine or tension-type headache variant, it could lead to erroneous clinical diagnosis and complacency with respect to the need for investigations, especially in those with a history of migraine headache. Therefore, until the pathogenesis of idiopathic thunderclap headache is elucidated, the term “crash migraine” should be abandoned if for no other reason than to avoid the misunderstanding that this is a legitimate presentation of migraine.

### DIAGNOSTIC EVALUATION OF THUNDERCLAP HEADACHE

#### Idiopathic thunderclap headache is a diagnosis of exclusion

This statement cannot be overemphasised because of the serious nature of the potential intracranial causes. Sudden severe headache is the most common symptom of a subarachnoid haemorrhage. It may precede an imminent subarachnoid haemorrhage in 10%–50% of patients or may be the sole manifestation of a subarachnoid haemorrhage. Unfortunately, there are no characteristics of the headache which reliably distinguish between subarachnoid haemorrhage and idiopathic thunderclap headache and therefore a thorough diagnostic evaluation is mandatory.<sup>60</sup>

“Idiopathic thunderclap headache is a diagnosis of exclusion. This statement cannot be overemphasised because of the serious nature of the potential intracranial causes”

Brain CT is obligatory in all patients. Both retrospective and prospective studies which have recently evaluated third generation CT scanners in subarachnoid haemorrhage show a sensitivity of 100% and 98% respectively within the first 12 hours after the onset of headache, and 93% within the first 24 hours.<sup>7</sup> Although these figures are promising, expert neuroradiologists interpreted the scans in most of these studies. In general practice, physicians are less experienced in reading CT scans, and subtle abnormalities are undoubtedly overlooked. Furthermore, the sensitivity of CT decreases to 86% 1 day after the onset of headache, 76% after 2 days, and 58% 5 days later.<sup>61</sup>

A lumbar puncture therefore is required in all patients whose initial CT is negative, equivocal, or technically inadequate. The CSF pressure should *always* be measured as high intracranial pressure may be an important clue to the presence of cerebral venous sinus thrombosis where about 25% of CT scans will be negative. Increased opening pressure may also help distinguish between a traumatic lumbar puncture and a subarachnoid haemorrhage. It is vital that this distinction be made as about 20% of lumbar punctures are traumatic, and simply looking for a decrement in the erythrocyte count in three successive tubes is not entirely reliable. In addition, if the fluid is not promptly centrifuged and examined, erythrocytes resulting from a traumatic tap may undergo lysis *in vitro* producing xanthochromia from the formation of oxyhaemoglobin. Visual inspection for xanthochromia can miss discoloration in up to 50% of specimens. The detection of xanthochromia by spectrophotometry is the most accurate test for subarachnoid haemorrhage with a sensitivity of 100% when a lumbar puncture is performed between 12 hours to 2 weeks after the ictus.<sup>62</sup>

The contentious issue has been whether intra-arterial digital subtraction angiography is required to exclude an unruptured aneurysm in patients with thunderclap headache, a normal neurological examination, and a normal CT and CSF examination. The evidence that unruptured intracranial aneurysms can present in this fashion is scarce and incomplete and as previously discussed, in most cases, the aneurysm was quite likely an incidental finding. The balance of evidence from prospective studies indicates that this presentation is benign. In a retrospective study of 71 patients with thunderclap headache whose results on CT and lumbar puncture were negative, none of the patients had subarachnoid haemorrhage during an average follow up period of 3.3 years.<sup>20</sup> Furthermore, in four prospective studies, a total of 225 patients with thunderclap headache and negative CT and lumbar punctures were followed up for one year or more, and none of the patients had a subarachnoid haemorrhage or sudden death.<sup>21–24</sup>

In cases where the CSF or clinical findings are difficult to interpret or the index of suspicion is unusually high (family or personal history of subarachnoid haemorrhage), MRA is an appropriate procedure for detecting a saccular aneurysm in most patients. Magnetic resonance angiography and CT angiography (CTA) offer non-invasive methods of evaluating patients for the presence of an intracranial aneurysm. In a recent meta-analysis, 18 adequate quality studies of MRA for the detection of intracranial aneurysms were identified.<sup>44</sup> The sensitivity varied between 69% and 100%, and the specificity was 75%–100%. Aneurysm size has been an important factor in aneurysm detection, with studies of MRA consistently indicating sensitivity rates of greater than 95% for aneurysms greater than 6 mm in diameter.

Computed tomographic angiography has been studied less extensively than MRA, but published data of CTA versus intra-arterial digital subtraction angiography indicate that spiral CTA is at least as good, if not more accurate than MRA, with overall detection rates of 85%–98%.<sup>63,64</sup> Digital subtraction angiography with selective cerebral arterial injections and multiple projections is invasive and costly, may require a stay in hospital, and carries an overall 1% risk of transient and 0.5% risk of permanent neurological complication. The risk may be

higher in patients with thunderclap headache, especially in the presence of diffuse vasospasm.<sup>65-66</sup> CTA has some disadvantages compared with MRA in that it requires an injection of iodine based contrast which exposes patients to radiation (~ 2 mSv—roughly equivalent to ~ 1 year of background radiation), and carries a small risk of an allergic reaction or a deterioration in renal function.

Thus, if unruptured cerebral aneurysms can present with thunderclap headache with a normal neurological examination, negative CT and lumbar puncture, it would seem to be an exceedingly uncommon occurrence and certainly does not justify intra-arterial digital subtraction angiography on all or even most patients.

## CONCLUSION

Thunderclap headache is a clinical emergency which mandates a swift evaluation with investigations aimed at excluding a subarachnoid haemorrhage. Early CT has high sensitivity and specificity for detecting subarachnoid blood. However, when negative, lumbar puncture is always required. In those patients with normal neurological, CT, and CSF examinations, further imaging to search for an unruptured intracranial aneurysm is not warranted and may be misguided. Prospective studies indicate that the overwhelming majority of these patients have an excellent long term prognosis without an increased risk of subarachnoid haemorrhage or sudden death and there is as yet precious little evidence that patients with unruptured aneurysms can present with thunderclap headache. Furthermore, given the prevalence of unruptured aneurysms in the population, the likelihood of uncovering one as an incidental finding is not remote, and implications of such a finding are not inconsequential.

On the other hand, acute neurological emergencies such as cervicophalic arterial dissection and cerebral venous sinus thrombosis may present with thunderclap headache as the earliest or only symptom in a significant minority of patients. Brain CT is often negative in these cases, and lumbar puncture is either negative as in the case of arterial dissection, or may only demonstrate increased opening pressure in patients with cerebral vein thrombosis. Because of the neurological morbidity associated with delayed ischaemic or haemorrhagic events in these conditions, prompt and early diagnosis is imperative. In these cases, MR angiography is the imaging procedure of choice.

When appropriate investigations have excluded all potential secondary causes, a diagnosis of idiopathic thunderclap headache is appropriate. This disorder may be associated with angiographic evidence of diffuse multifocal cerebral vasospasm. Although this unusual angiographic abnormality is reversible and self limited, careful clinical observation is warranted, especially if focal neurological symptoms occur.

## ACKNOWLEDGEMENT

I express my gratitude and appreciation to Professor MG Bousser for her valuable advice during the preparation of this manuscript.

## REFERENCES

- Day JW, Raskin NH. Thunderclap headache: symptom of unruptured cerebral aneurysm. *Lancet* 1986;ii:1247-8.
- Dodick DW, Wijidicks EFM. Pituitary apoplexy presenting as thunderclap headache. *Neurology* 1998;50:1510-11.
- de Bruijn SFTM, Stam J, Kappelle LJ for the CVST Study Group. Thunderclap headache as the first symptom of cerebral venous sinus thrombosis. *Lancet* 1996;348:1623-5.
- Tang-Wai DF, Phan TG, Wijidicks EFM. Hypertensive encephalopathy presenting with thunderclap headache. *Headache* 2001;41:198-200.
- Schievink WI, Wijidicks EFM, Meyer FM, et al. Spontaneous intracranial hypotension mimicking aneurysmal subarachnoid hemorrhage. *Neurosurgery* 2001;48:513-17.
- Embil JM, Matthias K, Kinnear R. A blinding headache. *Lancet* 1997;350:182.
- Edlow JA, Caplan LR. Avoiding pitfalls in the diagnosis of subarachnoid hemorrhage. *N Engl J Med* 2000;342:29-36.
- Hauerberg J, Andersen BB, Eskesen V, et al. Importance of the recognition of a warning leak as a sign of a ruptured intracranial aneurysm. *Acta Neurol Scand* 1991;83:61-4.
- Edner G, Ronne-Engstrom E. Can early admission reduce aneurysmal rebleeds? A prospective study on aneurysmal incidence, aneurysmal rebleeds, admission and treatment delays in a defined region. *Br J Neurosurg* 1991;5:601-8.
- Leblanc R. The minor leak preceding subarachnoid hemorrhage. *J Neurosurg* 1987;66:35-9.
- Linn FHH, Rinkel GJE, Algra A, et al. The notion of "warning leaks" in subarachnoid hemorrhage: are such patients in fact admitted with a rebleed? *J Neural Neurosurg Psychiatry* 2000;68:332-6.
- Clarke CE, Shepherd DI, Christl K, et al. Thunderclap headache. *Lancet* 1988;ii:625.
- Witham TF, Kaufmann AM. Unruptured cerebral aneurysm producing a thunderclap headache. *Am J Emerg Med* 2000;18:1-6.
- Wardlaw JM, White PM. The detection and management of unruptured intracranial aneurysms. *Brain* 2000;123:205-21.
- Dodick DW, Brown RD, Britton JW, et al. Non-aneurysmal thunderclap headache with diffuse, multifocal, segmental, and reversible vasospasm. *Cephalalgia* 1999;19:1-6.
- Abbott RJ, van Hille P. Thunderclap headache and unruptured cerebral aneurysm. *Lancet* 1986;ii:1459.
- Ng PK, Pulst S-M. Not so benign "thunderclap headache" [abstract]. *Neurology* 1992;42(suppl 3):260.
- Raps EC, Rogers JD, Galetta SL, et al. The clinical spectrum of unruptured intracranial aneurysms. *Arch Neurol* 1993;50:265-8.
- Takeuchi T, Kasahara E, Iwasaki M, et al. Necessity for searching for cerebral aneurysm in thunderclap headache patients who show no evidence of subarachnoid hemorrhage: Investigation of eight minor leak cases on operation. *No Shinkei Geka* 1996;24:437-41. (In Japanese.)
- Wijidicks EFM, Kerkhoff H, Van Gijn. Long term follow up of 71 patients with thunderclap headache mimicking subarachnoid hemorrhage. *Lancet* 1988;ii:68-70.
- Harling DW, Peatfield RC, Van Hille PT, et al. Thunderclap headache: is it migraine? *Cephalalgia* 1989;9:87-90.
- Markus HS. A prospective follow up of thunderclap headache mimicking subarachnoid hemorrhage.
- Linn FHH, Rinkel GJE, Algra A, et al. Follow up of idiopathic thunderclap headache in general practice. *J Neurol* 1999;246:946-8.
- Landtblom AM, Boivie J, Fridriksson S, et al. Thunderclap headache: final results from a prospective study of consecutive cases. *Acta Neurol Scand* 1996;167(suppl 94):23-4.
- De Bruijn SF, Stam J, Kapelle LJ for the CVST Study Group. Thunderclap headache as first symptom of cerebral venous sinus thrombosis. *Lancet* 1996;348:1623-5.
- Rao KCVG, Knipp HC, Wagner EJ. CT findings in cerebral sinus and venous thrombosis. *Radiology* 1981;140:391-8.
- Chiras J, Bousser MG, Meder JF, et al. CT in cerebral thrombophlebitis. *Neuroradiology* 1985;27:145-54.
- Bousser MG, Chiras J, Sauron B, et al. Cerebral venous thrombosis. A review of 38 cases. *Stroke* 1985;16:199-213.
- Barinagarrementeria F, Cantu C, Arredondo H. Aseptic cerebral venous thrombosis: proposed prognostic scale. *Journal of Stroke and Cerebrovascular Disease* 1992;2:34-9.
- Bousser MG, Russell RR. Cerebral venous thrombosis. In: *Major problems in neurology*. London: WB Saunders, 1999.
- Bioussé V, D'Anglejan J, Touboui PJ, et al. Headache in 67 patients with extracranial internal carotid artery dissection. *Cephalalgia* 1991;17:232-3.
- Silbert PL, Mokri B, Schievink WI. Headache and neck pain in spontaneous internal carotid and vertebral artery dissections. *Neurology* 1995;45:1517-22.
- Mokri B. Traumatic and spontaneous extracranial internal carotid artery dissections. *J Neurol* 1990;237:356-61.
- Bogousslavsky J, Despland PA, Regli F. Spontaneous carotid dissection with acute stroke. *Arch Neurol* 1987;44:137-40.
- Soloman S, Lipton RB, Harris PY. Arterial stenosis in migraine: spasm or arteriopathy? *Headache* 1990;30:52-61.
- Snyder BD, McClelland RR. Isolated benign cerebral vasculitis. *Arch Neurol* 1978;35:612-14.
- Garnic JD, Schellinger D. Arterial spasm as a finding intimately associated with the onset of vascular headache. *Neuroradiology* 1983;24:273-6.
- Miller Fisher C. Honored guest presentation: painful states: a neurological commentary. *Clin Neurosurg* 1984;31:32-53.
- Serdaru M, Chiras J, Cugas M, et al. Isolated benign cerebral vasculitis or migrainous vasospasm? *N Neurol Neurosurg Psychiatry* 1984;47:73-6.
- Schon F, Harrison MJH. Can migraine cause multiple segmental cerebral artery constrictions?
- Masuzawa T, Shinoda S, Furuse M, et al. Cerebral angiographic changes on serial examination of a patient with migraine. *Neuroradiology* 1983;24:277-81.
- Silbert PL, Hankey GJ, Prentice DA, et al. Angiographically demonstrated arterial spasm in a case of benign sexual headache and benign exertional headache. *Aust N Z J Med* 1989;19:466-8.
- Strittmatter M, Zimmermann C, Schmirigk K, et al. Thunderclap headache: an independent form of headache? *Wein Klin Wochenschr* 1996;108:326-9.
- Slivka A, Philbrook B. Clinical and angiographic features of thunderclap headache. *Headache* 1995;35:1-6.

- 45 **Sturm JW**, MacDonell R. Recurrent thunderclap headache associated with reversible intracerebral vasospasm causing stroke. *Cephalalgia* 2000; (in press).
- 46 **Call GK**, Fleming MC, Sealfon S, *et al.* Reversible cerebral segmental vasoconstriction. *Stroke* 1988;**19**:1159–70.
- 47 **Bogousslavsky J**, Despland PA, Regli F, *et al.* Postpartum cerebral angiopathy: reversible vasoconstriction assessed by transcranial doppler ultrasound. *Eur Neurol* 1989;**29**:102–5.
- 48 **Henry PY**, Larre P, Aupy M, *et al.* Reversible cerebral arteriopathy associated with the administration of ergot derivatives. *Cephalalgia* 1984;**4**:171–8.
- 49 **Kumar R**, Wijidicks EFM, Brown RD, *et al.* Isolated angitis of the CNS presenting as subarachnoid hemorrhage. *J Neurol Neurosurg Psychiatry* 1997;**62**:649–51.
- 50 **Armstrong FS**, Hayes GJ. Segmental cerebral arterial constriction associated with pheochromocytoma. *J Neurosurg* 1961;**18**:843–6.
- 51 **Trommer BL**, Homer D, Mikhael MA. Cerebral vasospasm and eclampsia. *Stroke* 1988;**19**:326–9.
- 52 **Margolis MT**, Newton TH. Methamphetamine ("speed") arteritis. *Neuroradiology* 1971;**2**:179–82.
- 53 **Kaye BR**, Fainstat H. Cerebral vasculitis associated with cocaine abuse. *JAMA* 1984;**258**:2104–6.
- 54 **Edvinsson L**, Gulbenkian S, Barroso CP, *et al.* Innervation of the human middle meningeal artery: immunohistochemistry, ultrastructure, and role of endothelium for vasomotility. *Peptides* 1998;**19**:1213–25.
- 55 **Edvinsson L**, Owman C. Cerebrovascular nerves and vasomotor receptors. In Wilkins RH, ed. *Cerebral arterial spasm*. Baltimore: Williams and Wilkins, 1980:30–6.
- 56 **Endo S**, Suzudi J. Experimental cerebral vasospasm after subarachnoid hemorrhage: participation of adrenergic nerves in cerebral vessel wall. *Stroke* 1979;**10**:703–11.
- 57 **Edvinsson L**, Egund N, Owman CH, *et al.* Reduced noradrenaline uptake and retention in cerebrovascular nerves associated with angiographically visible vasoconstriction following experimental subarachnoid hemorrhage in rabbits. *Brain Res Bull* 1982;**9**:799–805.
- 58 **Dodick DW**. Recurrent short-lasting headache associated with paroxysmal hypertension: a clonidine responsive syndrome. *Cephalalgia* 2000;**20**:509–14.
- 59 **International Headache Society**. Classification and diagnostic criteria for headache disorders, cranial neuralgias, and facial pain. *Cephalalgia* 1988;**8**(suppl 7):1–96.
- 60 **Linn FHH**, Rinkel GJE, Algra A, *et al.* Headache characteristics in subarachnoid hemorrhage and benign thunderclap headache. *J Neurol Neurosurg Psychiatry* 1998;**65**:791–93.
- 61 **Van Gijn J**, van Dongen KJ. The time course of aneurysmal hemorrhage on computed tomograms. *Neuroradiology* 1982;**23**:153–6.
- 62 **Vermulen M**, Hasan D, Blijenberg BG, *et al.* Xanthochromia after subarachnoid hemorrhage needs no revisitation. *J Neurol Neurosurg Psychiatry* 1989;**52**:826–8.
- 63 **Alberico RA**, Patel M, Casey S, *et al.* Evaluation of the circle of Willis with three-dimensional CT angiography in patients with suspected intracranial aneurysms. *AJNR Am J Neuroradiol* 1995;**16**:1571–8.
- 64 **Hope JK**, Wilson JL, Thomson FJ. Three-dimensional CT angiography in the detection and characterization of intracranial berry aneurysms. *AJNR Am J Neuroradiol* 1996;**17**:439–45.
- 65 **Raynor RB**, Ross GR. Arteriography and vasospasm. *J Neurosurg* 1969;**17**:1055–60.
- 66 **Warnock NG**, Gandhi MR, Bergvall U, *et al.* Complications of intraarterial digital subtraction angiography in patients investigated for cerebral vascular disease. *Br J Radiol* 1993;**66**:855–85.

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