

RESEARCH ARTICLE

Open Access

A systematic review of causes of sudden and severe headache (Thunderclap Headache): should lists be evidence based?

Emma Devenney, Hazel Neale and Raeburn B Forbes*

Abstract

Background: There are many potential causes of sudden and severe headache (thunderclap headache), the most important of which is aneurysmal subarachnoid haemorrhage. Published academic reviews report a wide range of causes. We sought to create a definitive list of causes, other than aneurysmal subarachnoid haemorrhage, using a systematic review.

Methods: Systematic Review of EMBASE and MEDLINE databases using pre-defined search criteria up to September 2009. We extracted data from any original research paper or case report describing a case of someone presenting with a sudden and severe headache, and summarized the published causes.

Results: Our search identified over 21,000 titles, of which 1224 articles were scrutinized in full. 213 articles described 2345 people with sudden and severe headache, and we identified 6 English language academic review articles. A total of 119 causes were identified, of which 46 (38%) were not mentioned in published academic review articles. Using capture-recapture analysis, we estimate that our search was 98% complete. There is only one population-based estimate of the incidence of sudden and severe headache at 43 cases per 100,000. In cohort studies, the most common causes identified were primary headaches or headaches of uncertain cause. Vasoconstriction syndromes are commonly mentioned in case reports or case series. The most common cause not mentioned in academic reviews was pneumocephalus. 70 non-English language articles were identified but these did not contain additional causes.

Conclusions: There are over 100 different published causes of sudden and severe headache, other than aneurysmal subarachnoid haemorrhage. We have now made a definitive list of causes for future reference which we intend to maintain. There is a need for an up to date population based description of cause of sudden and severe headache as the modern epidemiology of thunderclap headache may require updating in the light of research on cerebral vasoconstriction syndromes.

Keywords: Thunderclap headache; Sudden headache; Acute headache; Systematic review; Publication bias

Background

Sudden and Severe Headache is a common reason for seeking urgent medical advice [1], primarily to exclude aneurysmal subarachnoid haemorrhage [2].

In the process of developing a guideline for managing acute headache we observed variation in the range of diagnoses published [3-9], so we conducted a systematic review of literature to compile a comprehensive list of potential causes other than aneurysmal subarachnoid haemorrhage.

We estimate completeness of ascertainment of causes using capture-recapture methods, and discuss the implications of using systematic review methods for lists of causation, paying attention to the issue of publication bias.

Methods

We searched MEDLINE and EMBASE databases in September 2009 using pre-specified search criteria (Table 1), designed and implemented by a professional librarian (HN), as the Medical Subject Heading (MeSH term) for Thunderclap Headache excludes articles indexed prior

* Correspondence: raeburnforbes@southern.trust.hscni.net
Department of Neurology and Medical Library, Craigavon Area Hospital,
Southern HSC Trust, County Armagh, Northern Ireland BT63 5QQ, UK

Table 1 Search criteria to identify articles on sudden and severe headache (performed September 2009)

Ovid MEDLINE(R)	EMBASE	1996-2009	1988-95	1980-87
Search terms	Search terms			
1. headache/di, ep, et, co, mo, cf, ra	1. exp primary headache/	165	0	0
2. headache disorders, primary/	2. exp cough headache/	15	0	0
3. vascular headaches/	3. exp exertional headache/	17	0	1
4. intracranial hypertension/	4. exp hypnic headache/	81	0	0
5. intracranial hypotension/	5. exp postural headache/	24	1	0
6. pseudotumor cerebri/	6. exp secondary headache/	43	0	0
7. intracranial vasospasm/	7. exp thunderclap headache/	84	0	9
8. (acute disease/ or catastrophic illness.mp. or critical illness/ or emergencies/) and (headache/ or headache disorder/) [mp=title, original title, abstract, name of substance word, subject heading word]	8. exp vascular headache/	88	0	1
9. 7 and (headache/ or headache disorder/)	9. (coitus/ or orgasm/) and exp "headache and facial pain"/	118	14	7
10. thunderclap headache?.mp.	10. exp acute disease/ and exp "headache and facial pain"/	624	17	20
11. coit*.mp. and (headache/ or headache disorder/)	11. exp intracranial hypotension/	589	8	11
12. call fleming.mp.	12. exp brain pseudotumor/ and exp "headache and facial pain"/	387	60	2
13. worst headache?.mp.	13. exp brain vasospasm/ and exp "headache and facial pain"/	181	18	11
14. sentinel headache?.mp.	14. thunderclap headache?.mp.	165	11	0
15. explosive headache?.mp.	15. coit*.mp. and exp "headache and facial pain"/	61	16	1
16. reversible cerebral vaso*.mp.	16. call fleming.mp.	16	0	3
17. postpartum angio*.mp.	17. worst headache?.mp.	21	5	0
18. postpartum vasc*.mp.	18. sentinel headache?.mp.	14	3	0
19. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18	19. explosive headache?.mp.	6	1	0
	20. reversible cerebral vaso*.mp.	45	1	66
	21. postpartum angiopathy.mp.	14	0	57
Gross total references	20338 Gross total references	2758	155	57
Duplicates	1547 Duplicate references	18	14	0
Net total references from MEDLINE	18791 Net total references	2395	141	57
All references Identified				21384

to November 1999 [10]. We screened titles of publications for potential cases, case series, cohort studies or academic reviews of people with a sudden AND severe headache. Cases were included if the presenting headache was both sudden in onset AND severe in intensity. Cases were excluded if a headache onset was not sudden or if onset was not reported (even the headache was severe or a significant aetiology was subsequently found). Similarly, if a sudden headache was described but there was no description of the severity of the pain, we excluded the case. We excluded publications concerning aneurysmal subarachnoid haemorrhage, as the major purpose of our systematic review was to identify other causes. Publications on Exploding Head Syndrome [11], Neuralgic disorders,

such as Idiopathic Stabbing Headaches [12], or Trigeminal Neuralgia [13] were also excluded, as these are characteristic syndromes in their own right. However, these diagnoses could be included if they were reported as the final diagnosis in someone presenting with a sudden AND severe headache.

We included Academic Review articles, as we wanted to compare causes published in academic reviews with those obtained from the data sourced from our systematic review. Academic Review articles had to describe thunderclap headache or the differential diagnosis of thunderclap headache, and not just headache seen in the Emergency Department. We drew up lists of causes which were (a) identified in original articles only, (b) identified in

academic review articles only and (c) identified in both original articles and academic reviews.

We were unable to use the International Headache Classification [14], as the majority of authors had not used criteria, and there was usually insufficient information to allow a retrospective classification. We therefore classified cases according to causation.

Non-English publications

We were not funded for translation services. Once we had completed the review of English publications, we used an online translation tool [15], and entered text from non-English articles to try and identify additional causes from non-English publications. As we were not able to have these papers translated professionally, we summarised these articles separately.

Statistics and analysis

We used descriptive, summary statistics and stratified our diagnostic categories according to whether the source cases were from case reports, case series or cohort studies.

We were specifically interested in whether there was variation between different study types, as publication bias would suggest that conditions that are rare in unselected populations would be over-represented in the medical literature. We were also interested in exploring any differences between lists of causes identified by Academic Review articles and the list we ultimately generated from our systematic review.

To assess the completeness of our diagnostic list we used a capture-recapture method to estimate the number of unobserved diagnoses [16].

We were advised by our local research ethics committee that formal approval was not required as this research did not involve human subjects, and was a systematic review of published literature.

Results

Our search strategy, executed in September 2009, identified 21,384 potential articles (Table 1). On review of titles we created a shortlist of 1224 publications. The abstracts of these 1224 full text articles were reviewed. 151 publications were duplicates (i.e. listed on both EMBASE and MEDLINE), leaving 1073 papers. Of these 1073, 70 required translation (which we did not have funding to do), and 27 were not traceable, even following inter-library loan requests.

Of the remaining 976 articles, 213 met inclusion criteria of describing a total of 2345 people with sudden and severe headache:

- 194 Case Report articles describing 321 people
- 13 Case Series articles describing 375 people
- 6 Cohort articles describing 1649 people.

Only one study had prospective, unselected population-based information on the incidence of Sudden Headache - estimating an annual incidence of 43 cases per 100,000 adults [17].

A further 6 articles were identified which were English Language Academic Review articles on Thunderclap Headache that described causes of sudden AND severe i.e. 'Thunderclap' headache [3,4,6,7,18,19].

This systematic review is therefore based upon a total of 219 English publications (213 original articles and 6 academic reviews). The 764 articles excluded articles were reviews related to acute headache, the investigation of headache, editorial comment or publications of new onset headache where onset AND severity were not reported.

Of the 70 non-English articles, we excluded 29 after using an online translation tool. Of the remaining 41 non-English Language articles, 22 were case reports which included 29 cases, none of which reported causes of sudden and severe headache that were unreported in our English Language papers. There were 8 case series and 4 cohort studies looking at unselected series of people with acute headache. A further 6 non-English academic review articles were identified that examined thunderclap headache [20-25].

Completeness of ascertainment of systematic review

There were a total of 69 distinct clinical syndromes associated with Sudden AND Severe Headache that were mentioned in academic review articles AND were identified in our own literature search. We identified 46 distinct clinical syndromes associated with Sudden and Severe Headache that were unique to our systematically reviewed literature, and there were 4 diagnoses mentioned in the academic review articles as causes of Thunderclap Headache, but we did not find any citation in our own search strategy ('Crash Migraine', Hypnic Headache, Anterior Cerebral Artery Aneurysm (although we identified a case of middle cerebral artery aneurysm), and Cluster Headache).

If we assume that we missed these 4 causes, then our search strategy has probably identified about 98% of known causes of sudden and severe headache (Table 2).

Relative frequency of causes, according to type of study

The frequency of causes depended on the type of study performed (Table 3).

By definition, case reports and case series would not contain any people with sudden and severe headache in whom a cause was uncertain or unknown. There were no published case reports of common primary headaches, such as migraine, tension-type headache or cluster headache manifesting as sudden and severe headache (Table 3). On the other hand, Reversible Cerebral Vasoconstriction Syndromes were not explicitly mentioned in any of the

Table 2 Estimated efficiency of systematic search for causes of sudden and severe headache

		In academic review	
		Yes	No
In systematic review	Yes	69**	46
	No	4	*Estimated 3 articles unobserved

*Where the number of unobserved cases is equal to $(46 \times 4) / 69$ (see reference [16,26].

**If we count all vasoconstriction syndromes as one single cause, then the value of this cell in 45, but the number of unobserved cases would still be close to 3.

published cohort studies, but were common subjects of case series and case reports.

In cohort studies (Table 3), where neurologists were responsible for assigning diagnoses, the 'not-specified' populations (28%) make the largest group of people. Overall, from cohort studies, 75% of cases of sudden and severe headache are assigned to either a primary headache disorder (27%), a non-specific headache (28%), Idiopathic Thunderclap Headache (17%) or an uncertain headache disorder (3%).

In cohort studies, a Cerebrovascular Disorder (17%) is most the most likely identifiable cause. Cerebral Vasoconstriction Syndromes were not explicitly reported in any of the cohort studies, but systemic or CNS infections, including sinusitis, meningitis and viral illness are reasonably frequently associated with sudden and severe headache (7%).

Cervicocephalic Arterial Dissection (0.1% of cohort cases) and Cerebral Venous Sinus Thrombosis (0.2% of cohort cases) are often cited as causes of sudden and severe headache, and featured prominently from our case series and case reports, yet occur infrequently in cohort studies. Pituitary Apoplexy was not reported in any of the cohort studies.

Other rare causes from cohort studies that were not published in case reports included Acute Cranial Herpes Zoster [27], Herpes Encephalitis [28], HaNDL Syndrome [27], Cerebral Oedema [17,29] and Alcohol-Induced Headache [27].

Case series are usually single institution experiences of diagnosis and management of a single cause of sudden and severe headache. Cerebrovascular causes predominate, such as Reversible Cerebral Vasoconstriction Syndrome [30] (Table 3). In the Case Reports, cerebrovascular causes accounted for 47% of published cases (Table 3).

'Musculoskeletal headaches' were listed in one cohort study [31], but Bath-related Headache [32], Pituitary Apoplexy [33] and Occipital Neuralgia [34] were not mentioned in cohort studies. A series on unruptured intracranial aneurysm proposed that expansion or thrombosis could lead to symptoms without rupture or subarachnoid haemorrhage [35].

Idiopathic thunderclap headache

Of the 459 people we identified with Idiopathic Thunderclap Headache there were a range of provoking activities, including sexual activity, bathing, and exertion (Table 4). In these 459 cases vasoconstriction was not sought or if sought, was not identified.

Infection associated thunderclap headache

Cohort Studies identified infections in 7% of cases, and these were either unidentified infections or related to rhinosinusitis (Table 5). There has been at least one large series of aseptic meningitis where several cases presented with sudden and severe headache (Table 5). There are isolated case reports of sudden and severe headache which seem to be related to relatively rare infections such as Q-Fever and Erve Virus [68].

Cerebrovascular disease

We separated these cases into groups where there was no evidence of segmental arterial constriction non-vasoconstrictive aetiology (398 cases - Table 6) and vasoconstriction syndromes, (234 cases - Table 7).

A wide range of non-vasoconstrictive pathologies exist that could provoke sudden and severe headache, including all types of intracranial haemorrhage (subdural, subarachnoid, intracerebral and one single case of epidural

Table 3 Sudden AND severe headache causation by group and type of publication

Cause	Cohort (N)	%	Case (N)	%	Case series	%	All (N)	%
Idiopathic thunderclap headache	265	16	87	27	107	29	459	20
Other, not specified	457	28	18	6	0	0	475	20
Primary headache	447	27	0	0	0	0	447	19
Cerebrovascular	281	17	153	47	198	53	632	27
Infection	119	7	17	5	24	6	160	7
Unknown	49	3	0	0	0	0	49	2
Non-neurovascular	27	2	46	14	46	12	119	5
Sudden death with headache	4	0.2	0	0	0	0	4	0
Total	1,649	100	321	99	375	100	2345	100

Table 4 459 cases of idiopathic thunderclap headache, by study type and provocation

Study type	Final diagnosis	N	Provocation
Case	Bath-Related Thunderclap Headache [36-40]	16	Bathing
Series	Bath-Related Thunderclap Headache [32]	21	Bathing
Case	Weight lifters headache [41,42]	3	Exertion
Case	Primary Exertional [43-45]	7	Exertion
Cohort	Primary Exertional Headache [27]	17	Exertion
Case	Swimming headache followed by exertional and coital headache [46]	2	Exertion
Case	Primary Thunderclap Headache [47-49]*	13	Idiopathic
Cohort	Primary Thunderclap Headache [27-29,50]	200	Idiopathic
Case	Headache Associated with Sexual Activity [51-63]	42	Sexual activity
Cohort	Headache Associated with Sexual Activity ([17,27,31]	48	Sexual activity
Series	Headache Associated with Sexual Activity [53,64,65]	86	Sexual activity
Case	Combined Benign Exertional and Benign Sexual Headache [52,66,67]	4	Sexual activity
All	Total	459	

*One case reported singing as a provocation of Thunderclap Headache [47].

haematoma as a retroclival haematoma), arterial dissection, venous sinus thrombosis, expanding or thrombosed berry aneurysm, venous thrombosis. Intravascular air was reported in isolated case reports only. It is possible that some of the cases of convexity or intraparenchymal haemorrhage were secondary to vasoconstrictive processes,

but we were unable to confirm this from the published material.

Ischaemic stroke also features as an association of sudden and severe headache in cohort studies as well in individual case reports, but whether the infarction process is the cause of headache or whether

Table 5 160 cases of infection associated sudden and severe headache, by study type

Study type	Final diagnosis	N
Cohort	Viral Illness [31]	41
Cohort	Rhinosinusitis [27,31]	36
Cohort	Aseptic meningitis [17,27-29,69]	27
Series	Aseptic meningitis [70]	24
Cohort	Headache attributed to systemic viral infection [27]	9
Case	Erve virus infection [71]	7
Cohort	Bacterial meningitis [27,31,69]	4
Case	Erve virus infection and migraine [71]	2
Case	*Acute Q-fever with cerebellar & meningeal involvement [72]	1
Case	*Bacterial meningitis secondary to a transthemoidal encephalocele [73]	1
Case	*Dengue haemorrhagic fever [74]	1
Case	Pneumococcal Meningitis, lower lobe pneumonia [75]	1
Cohort	*Acute Cranial Herpes Zoster [27]	1
Cohort	Herpes Encephalitis [28]	1
Case	Erve Virus Infection and Sinusitis [71]	1
Case	Persistent Primary Thunderclap Headache - related to Erve virus [76]	1
Case	*Subarachnoid Haemorrhage due to <i>Borrelia burgdorferi</i> -associated vasculitis [77]	1
Case	Thunderclap headache secondary to complicated sinusitis [78]	1
	Subtotal cohort	119
	Subtotal case series	24
	Subtotal case reports	17

*Causes not mentioned in published Academic Reviews.

Table 6 398 cases of neurovascular thunderclap headaches, excluding vasoconstriction

Study type	Final diagnosis	N
	Intravascular Air (N = 2)	
Case	*Air embolus [79]	1
Case	*Cerebral Venous Air Embolism following dental implanation [80]	1
	Aneurysm (N = 18)	
Cohort	Unruptured Intracranial [27]	1
Cohort	Giant Aneurysm [28]	1
Series	Unruptured Intracranial Aneurysm [35]	7
Case	Unruptured Intracranial Aneurysm [48,81-83]	4
Case	*Recurrence and growth of previously coiled aneurysm [84]	2
Case	*Carotid artery aneurysm & carotid cavernous fistula [85]	1
Case	Unruptured Intracranial Aneurysm with Thrombosis [86]	1
Case	Carotid artery aneurysm thrombosis [87]	1
	Cervicocephalic Arterial Dissection (N = 31)	
Cohort	Carotid Artery Dissection [27]	1
Series	Vertebral Artery Dissection [88]	18
Case	Carotid Artery Dissection [89-91]	4
Case	*Basilar Artery Dissection (coital) [92]	2
Case	*Vertebral Artery Dissection with Reversible Cerebral Vasoconstriction Syndrome and RPLS [93]	1
Case	*Vertebral Artery Dissection, Subarachnoid Haemorrhage and PRES [93]	1
Case	Vertebral and Carotid Artery Dissection [94]	1
Case	*Vertebral Artery Dissection with Cerebellar Infarction [95]	1
Case	*Middle Cerebral Artery dissection [96]	1
Case	Vertebral Artery Dissection [97]	1
	Intracranial Haemorrhage (N = 252)	
Cohort	Subarachnoid Haemorrhage [17,27-29,31,69]	206
Cohort	Intracerebral Haemorrhage [17,28,29]	9
Cohort	Intracranial Haemorrhage [31]	1
Cohort	Subdural Haematoma [31]	1
Cohort	Haemorrhagic malignant glioma [28]	1
Series	Pre-truncal nonaneurysmal subarachnoid haemorrhage [98]	18
Case	Convexity Subarachnoid Haemorrhage [99]	3
Case	*Right convexity Subarachnoid Haemorrhage associated with right MCA atherosclerosis [99]	1
Case	*Simultaneous multiple brain haemorrhages associated with migraine, & cerebral amyloid angiopathy [100]	1
Case	Spontaneous Retroclival Haematoma [101]	1
Case	*Convexity Subarachnoid Haemorrhage with multiple brain abscesses [102]	1
Case	*Convexity Subarachnoid Haemorrhage with postpartum posterior encephalopathy [102]	1
Case	Convexity Subarachnoid Haemorrhage with vasculitis [102]	1
Case	*Trigeminal Haemorrhagic Inflammatory pseudotumour [103]	1
Case	Left thalamic haematoma [104]	1
Case	*Subarachnoid Haemorrhage secondary to ecchordosis physaliphora [105]	1
Case	*Headache secondary to diffuse subarachnoid density (blood and iohexol) on CT [106]	1
Case	Cerebellar Haemorrhage secondary to cerebellar angioma [107]	1
Case	Temporal Lobe Haematoma [107]	1
Case	Diffuse vasospasm after pretruncal nonaneurysmal subarachnoid haemorrhage [108]	1

Table 6 398 cases of neurovascular thunderclap headaches, excluding vasoconstriction (Continued)

Idiopathic (N = 4)		
Cohort	Arteriovenous Malformation [28]	1
Case	Posterior reversible leucoencephalopathy [109]	1
Case	Thrombotic thrombocytopenia [110]	1
Case	Hypertensive Encephalopathy [111]	1
Non-Haemorrhagic Stroke or Cerebral Infarction or Ischaemia (N = 66)		
Cohort	Stroke or Cerebral Infarction or Ischaemia [17,27-29,31]	56
Case	Ischaemic Cerebrovascular Disease [107]	3
Case	PICA Territory Infarction [112]	1
Case	Embolic Cerebellar Infarcts [113]	1
Case	Ischaemic stroke [114]	1
Case	Thunderclap Headache secondary to right semiovale infarction [115]	1
Case	Posterior cerebral artery infarction [116]	1
Case	Vertebral Artery Dissection with left lateral medullary infarction [117]	1
Case	*Occlusion of the posterior communicating artery [118]	1
Inflammatory Arteriopathy (N = 6)		
Case	Cerebral Angiitis [119,120]	3
Case	*Vogt-Koyanagi-Harada Disease [121,122]	2
Case	Subarachnoid Haemorrhage secondary to Inflammatory Vasculitis [123]	1
Cerebral Venous Sinus Thrombosis (N = 19)		
Cohort	Cerebral Venous Sinus Thrombosis [17,27,29]	3
Case	Cerebral Venous Sinus Thrombosis [124-129]	14
Case	Cerebral Venous Sinus Thrombosis with Intracerebral Haemorrhage [130]	1
Case	*Cerebral Venous Sinus Thrombosis with secondary Hydrocephalus [131]	1
		398

*Specific Aetiologies not mentioned in Academic reviews.

the headache was a manifestation of an occult vasculopathy, such as a vasoconstriction syndrome, remains uncertain (Table 6).

We identified 234 cases where vasoconstriction was a plausible or proven mechanism for headache. It was not always reported whether vasoconstriction was reversible, as this would require reporting of normal follow-up imaging. Vasoconstriction syndromes could be associated with a range of factors, specifically post-partum states [151], cocaine use [177], spontaneous intracranial hypotension [171], sickle-cell disease [185] and posterior leucoencephalopathy [160] (Table 7).

Non-vascular, neurological causes

5% of published cases had a non-vascular, neurological aetiology, including intracranial hypotension [189], pneumocephalus [190], pituitary apoplexy [33], other cerebral neoplasms [191], including colloid cyst of the third ventricle [192]. Psychological presentations [193] and post-seizure headache [27] were amongst reported causes of sudden and severe headache (Table 8).

Systemic illnesses

A small number of cases (13 in total) were reported in association with non-neurological, non-cerebrovascular causes, the most prominent of which was acute myocardial infarction (Table 9).

Comparison of causes identified in academic reviews versus systematic review

Of the causes not reported in academic reviews, and identified in our review, intracranial air, either intravascular or spontaneous pneumocephalus was the most frequently omitted cause (Table 8).

Case reports did identify potentially serious isolated causes of sudden and severe headache, specifically Aortic Dissection and Myocardial Infarction. Ecchordosis Physaliphora is a notochord related remnant which can cause intracranial haemorrhage, which was fatal in a published case report [105]. Psychologically mediated causes of Sudden and Severe Headache were also identified (Transitional Interpersonality Disorder and Hyperventilation Attacks). Perhaps surprisingly, there was no

Table 7 234 Cases of thunderclap headache with vasoconstriction

Vasoconstriction syndromes (N = 234)		
Series	Reversible Cerebral Vasoconstriction Syndrome [132,133]	99
Series	Recurrent primary thunderclap headache and benign CNS angiopathy [134]	56
Case	Reversible Cerebral Vasoconstriction Syndrome [135-149]	18
Case	Reversible Cerebral Vasoconstriction Syndrome associated with Subarachnoid Haemorrhage [150]	6
Case	Postpartum Angiopathy with Reversible Posterior Leukoencephalopathy [151]	4
Case	Thunderclap headache with segmental intracerebral vasoconstriction [152]	3
Case	Cerebral Vasoconstriction Syndrome (Call-Fleming Syndrome) with ischaemic stroke [153]	3
Case	Reversible cerebral vasoconstriction syndrome with Subarachnoid Haemorrhage [123]	3
Case	Thunderclap headache with diffuse, multifocal, segmental, and reversible vasospasm [154]	2
Case	*Bilateral parietooccipital convexity Subarachnoid Haemorrhage with vasoconstriction [99]	1
Case	*Left cerebral convexity Subarachnoid Haemorrhage with vasoconstriction [99]	1
Case	Complicated Migraine associated with orgasmic cephalgia [155]	1
Case	severe migraine variant with segmental cerebral arterial narrowing and watershed infarction [156]	1
Case	Reversible Cerebral Vasoconstriction Syndrome with Cerebral Infarction [157]	1
Case	Recurrent thunderclap headache with reversible intracerebral vasospasm and stroke [158]	1
Case	Diffuse Cerebral Vasospasm - possibly ergotamine associated [159]	1
Case	Reversible Cerebral Vasoconstriction Syndrome with posterior leukoencephalopathy syndrome [160]	1
Case	Bathing headache with diffuse vasospasm with posterior leukoencephalopathy [36]	1
Case	Delayed Eclampsia with associated vasospasm [161]	1
Case	Cerebral Vasoconstriction with right MCA cerebral infarction [162]	1
Case	Thunderclap headache with posterior leukoencephalopathy syndrome [163]	1
Case	*Orgasmic headache with Transient Basilar Artery Vasospasm [164]	1
Case	Orgasmic headache and cerebral vasospasm [165]	1
Case	Thunderclap headache with cerebral vasospasm [166]	1
Case	Call-Fleming PostPartum Angiopathy in the Puerperium [167]	1
Case	Posterior leukoencephalopathy associated with vasospasm [168]	1
Case	Nonaneurysmal subarachnoid haemorrhage with secondary cerebral vasoconstriction [169]	1
Case	Call-Fleming syndrome [170]	1
Case	*Reversible Cerebral Vasoconstriction Syndrome following Spontaneous Intracranial Hypotension [171]	1
Case	Call-Fleming Syndrome [172]	1
Case	Left frontal intracerebral haemorrhage secondary to benign angiopathy of the central nervous system [173]	1
Case	Reversible Cerebral Vasoconstriction Syndrome [135]	1
Case	Cerebral Vasoconstriction Syndrome with Subarachnoid Haemorrhage [174]	2
Case	Convexity Subarachnoid Haemorrhage, with sulcal haematoma secondary to cerebral vasoconstriction [174]	1
Case	Reversible Cerebral Vasoconstriction Syndrome causing right putaminal haemorrhage [175]	1
Case	Unruptured Intracranial Aneurysm with vasoconstriction [176]	1
Case	Cocaine related Neurovascular Headache [177]	1
Case	*Late onset eclampsia with cortical blindness [178]	1
Case	Reversible Cerebral Vasoconstriction Syndrome associated with orgasmic headache [179]	1
Case	*Tacrolimus Encephalopathy [180]	1
Case	Headache associated with Postpartum Cerebral Angiopathy [181]	1
Case	Reversible posterior leukoencephalopathy associated with minimal change disease [182]	1
Case	Post partum cerebral angiopathy (Call Fleming syndrome) [183]	1
Case	Eclamptic subarachnoid haemorrhage secondary to Post-partum cerebral angiopathy [184]	1

Table 7 234 Cases of thunderclap headache with vasoconstriction (Continued)

Case	*Recurrent PRES in a patient with sickle cell disease [185]	1
Case	Ipsilateral reversible cerebral vasoconstriction after Carotid Endarterectomy [186]	1
Case	Benign exertional and sexual headache with arterial spasm [187]	1
Case	Reversible cerebral vasoconstriction Syndrome associated oxymetazoline nasal spray [188]	1

*Specific Aetiologies not mentioned in Academic reviews.

Table 8 119 Neurological, non-vascular cases of thunderclap headache

Study type	Final diagnosis	N of cases
Intracranial Air (N = 6)		
Case	*Pneumocephalus associated with frontal pneumosinus dilatans [194]	1
Case	*Pneumocephalus [195-199]	5
40 CSF Pressure Disorders (N = 40)		
Cohort	Headache due to low CSF pressure [27]	14
Cohort	Idiopathic Intracranial Hypertension [27]	1
Cohort	*Cerebral Oedema [17,29]	2
Case	Spontaneous Intracranial Hypotension [79,189,200-206]	16
Case	Third Ventricle Colloid Cyst [192,207]	2
Case	*Adult aqueductal stenosis [208]	1
Case	Intracranial hypotension secondary to retained spinal needle [79]	1
Case	Intraventricular arachnoid cyst [209]	1
Case	Cerebellar tonsillar herniation [210]	1
Case	Hydrocephalus secondary to third ventricle dermoid cyst [211]	1
3 Neuro-Inflammatory Disorders (N = 3)		
Cohort	*HaNDL Syndrome [27]	1
Cohort	*Ocular Inflammatory Disorder [27]	1
Case	*Apoplectic headache secondary to Multiple Sclerosis [212]	1
4 Chemical Meningitis (N = 4)		
Case	*Rathke's cleft cyst [213,214]	2
Case	*Ruptured spinal dermoid tumour [215]	1
Case	*Ruptured arachnoid cyst into subdural space [216]	1
7 Intracranial Neoplasm (N = 7)		
Cohort	Neoplasm [27,31,69]	6
Case	*Nonhaemorrhagic Anaplastic Oligodendroglioma [191]	1
43 Pituitary Apoplexy (N = 43)		
Case	Pituitary Apoplexy [33,217-223]	8
Case	*Sphenoid sinus epidermoid cyst presenting as pituitary apoplexy [224]	1
Series	Pituitary Apoplexy [225]	34
1 Psychiatric Disorder (N = 1)		
Case	*Transitional Interpersonality Thunderclap Headache [193]	1
15 Other (N = 15)		
Cohort	*Post Seizure Headache [27]	2
Series	Occipital Neuralgia [34]	12
Case	*Hyperventilation Induced headaches [226]	1

119

*Specific Aetiologies not mentioned in Academic reviews.

Table 9 13 Cases with systemic illness in association with sudden and severe headache

Study type	Final diagnosis	N
Case		7
Case	Acute Myocardial Infarction [26,227-232]	8
Case	Aortic Dissection [233-235]	3
Case	Thunderclap Headache Secondary to Pheochromocytoma [236,237]	2
Case	Acute Puerpural headache & hypertension [238]	1
Case	Acute Intracranial Hypertension due to Occlusion of the Brachiocephalic vein [239]	1
Case	Coital Headaches induced by Amiodarone [240]	1
Case	Coital headache secondary to thyrotoxicosis ([51])	1
Cohort		6
Cohort	Musculoskeletal [234]	5
Cohort	Alcohol Induced Headache [234]	4
Cohort	Analgesic Overuse Headache [234]	3
Cohort	Arterial Hypertension [234]	1
Cohort	Amphetamine Misuse [234]	1
Cohort	Triptan overdose	1

publication of Munchausen's Syndrome as a cause of sudden and severe headache.

Non-English articles

The full text of a total of 29 non-English publications were examined once we had completed the main review of English Language publications - 27 case reports from 22 publications [241-263], and 599 cases from 8 case series [264-271]. The single large case series from Japan described 562 people with thunderclap headache, normal CT Brain and normal visually inspected CSF. Of these 562 people 52 berry aneurysms were identified at angiography, 46 of which went to surgery, 8 of which had evidence at surgery of recent haemorrhage, 4 of which had abnormal CSF cell count or protein levels [264,265].

There were 4 non-English language cohort studies [271-274], which did not identify any additional causes of abrupt, severe headache. In the 6 non-English academic review articles [20-25], ice-cream headache, exploding head syndrome and aortic coarctation were listed as potential causes of acute headache, although these causes were not identified in our own literature search, and exploding head syndrome was excluded as it is an intracranial noise rather than a headache.

Unique cases from non-English case report literature included Headache Associated with Sexual Activity associated with a Frontal Meningioma [246] or Intraventricular Arachnoid Cyst [244], Subarachnoid Haemorrhage secondary to Vertebral Artery Dissection [257], Convexity Subarachnoid Haemorrhage following Spinal Anaesthesia [249], Acute Hydrocephalus secondary to Chiari Malformation [259], and Pneumocephalus following inadvertent dural puncture at Epidural Anaesthetic [263].

4 cases of aneurysmal subarachnoid haemorrhage associated with normal CT Brain and normal appearing CSF (by visual inspection, not by spectrophotometry) were identified from a large case series from Japan [264,265]. The 4 non-English Language Cohort Studies did not identify causes that were not already identified from English language articles.

From the non-English academic reviews, Hypnic Headache, Cluster Headache, Exploding Head Syndrome, Ice-cream Headache and Aortic Coarctation were listed as causes of sudden and severe headache. It was not possible to get more clinical information on the published case of aortic coarctation which was included as part of a larger cohort.

Discussion

We present a comprehensive review of the literature on Sudden AND Severe Headache up to September 2009.

From our search, we estimate that we have identified 98% of all published causes of Sudden AND Severe Headache in the English Literature.

The literature on sudden and severe headache has some significant weaknesses, yet allows us to make some interesting observations on this potentially serious symptom and how information is reported in medical literature.

Prospective, longitudinal studies of unselected cases are crucial for determining accurate frequencies of incidence or cause. The only estimate of population-based incidence is from Sweden, at 43 cases per 100,000 adults per annum, which was estimated from a sub-set of the population in their study [17]. This figure is important as it is the only one that can inform service planning for the assessment of sudden and severe headache across a large population.

Our understanding of causes of sudden and severe headache is evolving, yet we do not have a precise knowledge of trends or causes of this symptom in a population over time. An emerging theme are the cerebral vasoconstriction syndromes which are attracting a lot more attention in the medical literature and since our literature review have been the subject of several major reviews [275,276], yet this cause was not described in any of the large cohort studies we found in our systematic review.

In cohort studies, where neurologists assigned diagnosis, headaches of unspecified cause, uncertain cause or a primary headache accounted for the majority of cases in unselected populations. This is contrary to hospital based clinical practice where a diagnosis of migraine, tension-type headache or cluster headache would hardly ever be used in the context of an abrupt onset of severe headache. Sudden and severe headache which remains unexplained following appropriate investigation would normally be called Primary or Idiopathic Thunderclap Headache. Reasons for this large number of unexplained or uncertain headaches remain obscure.

Another seemingly important cause of headache in a population is cervicogenic headache, which was identified in about 4% of adults in the Vaga Study [277]. The cohort studies identified a small number of 'musculoskeletal' related headaches [31] and there was one case series of occipital neuralgia presenting acutely to hospital [34], but otherwise this common headache is unreported as causing sudden and severe headache, yet seems a plausible candidate for many of the 'uncertain' or 'unclassified' cases.

Intracranial Hypotension is an important cause which featured in both cohort and case-based studies - so is both common enough to see in practice, and its treatable nature makes it reportable.

An up to date population-based study could make an important contribution to our current knowledge of sudden and severe headache, specifically the true incidence and prognosis of vasoconstriction syndromes, and better assessment of the clinical features and prognosis of those with 'uncertain' or 'unclassifiable' headaches.

Cases identified from series are important, as they aggregate information on relatively low frequency conditions as a reference for other clinicians. However, they distort the overall frequency of causes of headaches in our review eg pituitary apoplexy was not reported in the major cohorts. Nonetheless, accumulating cases of specific sub-types can greatly inform clinical practice and generate research hypotheses. An example of this is Headache Associated with Sexual Activity where a recent case series from Taiwan has identified the Reversible Cerebral Vasoconstriction Syndrome in almost 2/3rds of cases [278].

By their nature, case reports will focus on the esoteric or unusual, but our review has highlighted some

important associations including systemic conditions like Aortic Dissection [233,234,279,280], Cardiac Cephalgia [26,227-229,231,232,281-283], Pheochromocytoma [236,237], serious infections like Dengue Haemorrhagic Fever [74] and Q-Fever [72], as well as Erve Virus [68,71]. Rare vasculopathies such as Vogt-Kayanagi-Harada Disease [121,122], or cerebral vasculitis [119] do appear on the differential diagnosis. Another important presentation, identified in case reports only, was basilar artery dissection manifesting as a coital headache [92].

Cerebral vasculitis is commonly mentioned in discussions about sudden and severe headache, but in numeric terms, we only identified 6 cases of an 'inflammatory arteriopathy' compared to 234 cases of a likely vasoconstriction.

Vasoconstriction syndromes

There is evidence that many cases of otherwise unexplained Sudden AND Severe Headache, particularly coital headache, are actually due to Reversible Cerebral Vasoconstriction [278,284], and that pain is mediated by sympathetic innervated cerebral arteries. A recent systematic review of 214 cases of Reversible Cerebral Vasoconstriction Syndrome found 94% cases presented with thunderclap headache, which was often recurrent [276]. Our review identified 234 cases where vasoconstriction was the likely mechanism of headache (Table 9). Of these 234 cases, 37 (16%) had complications such as posterior leucoencephalopathy (11 cases, 5%), ischaemic stroke (7 cases, 3%) or haemorrhage (19 cases, 8%).

It is interesting to observe that low CSF pressure states have been accompanied by reversible cerebral vasoconstriction on one [171] if not 2 occasions [135]. This raises the intriguing possibility that Lumbar Puncture may not always be advisable when investigating a Thunderclap Headache if cerebral vasoconstriction is present. However, there is insufficient data to guide clinical practice at present.

Our review still supports the concept that Vasoconstriction Syndromes are probably part of a spectrum of disorders with an isolated sudden and severe headache at one end and multiple headaches and serious neurovascular complications at the other [278,284].

Publication bias

One of our review's objectives was to identify all causes as a prelude to writing a management guideline for Thunderclap Headache, and we were aware of relevant academic review articles [3-9]. Our systematic review did identify additional causes of sudden AND severe headache, such as Aortic Dissection and Pneumocephalus that were not specifically mentioned in these review articles. This is not to say that academic reviewers had no knowledge of these cases, but may merely reflect editorial practice. In fact 2 academic reviews stated search criteria

[3,18]. However, some causes of Thunderclap Headache are more commonly listed than others eg spontaneous retroclival haematoma, even when there has only ever been one solitary case published [101].

Our review collates a large number of published causes of sudden and severe headache and may serve as a benchmark for clinicians and researchers alike, as we estimate that our review may be 98% complete. Evidence based practice requires systematic critique of evidence, and our review is novel for applying this method to a list of causation. Medical lists are ubiquitous in medical education and clinical practice guidelines. The value of 'lists' is that information can be memorised and disseminated easily, but by being non-systematic they may perpetuate error as well as fact.

Limitations of this review and subsequent publications

Since the review completed, there have been some additional cases added to the medical literature, including spontaneous spinal epidural haematoma [285], and several more associations of the Reversible Cerebral Vasoconstriction Syndrome such as carotid glomus tumour [286] and Takayasu's Arteritis [287]. There has also been a major academic review on Thunderclap Headache published in 2013 [288] which did not identify additional cases to those mentioned in our own review [275]. We continue to monitor publications on thunderclap headache, but this paper will be limited to cases published by September 2009.

A potential criticism of this work is that we did not use the International Headache Society Classification of Headache Disorders. However, retrospective use of the criteria was not possible from the majority of published articles where criteria were not specified. If we had attempted to apply IHS criteria we may have created further error by assigning a classification without full information. Nonetheless, the objective of our review was to try and determine the full range of potential diagnoses that might emerge in someone who has presented for the assessment of a sudden and severe headache. We feel we have been as comprehensive and accurate as the published literature allows.

Using this data in clinical practice

In clinical practice, the differential diagnosis is central to organising diagnostic tests. The diagnostic evaluation is a screening process for target diseases. We can now argue that in a patient presenting with a sudden and severe headache that we have now created a definitive list of possible causes for sudden and severe headache i.e. we have quantified the possible diagnoses that have made it to the published literature, and that this list is arguably 98% complete.

The cohort studies provide the relative frequency with which target diseases might occur in practice, and it is

common sense to look for these in the first instance. The case series and case reports identify cases that illustrate unusual mechanisms for sudden and severe headache - for example myocardial infarction or pituitary apoplexy.

Clinicians looking to manage people with sudden and severe headache should now consider this list as a definitive reference, and if they think they identified an additional cause they can rapidly verify whether their case is unique, and therefore meriting publication.

Future research

As our paper has shown that there is a difference between the causes of sudden and severe headache published in academic reviews and those identified from a systematic review, it would be important to maintain this list on an ongoing basis as a reference point for clinicians and researchers.

Amongst potential problems in current medical publishing practice is that articles run out of date, and systematic reviews need updating. At present, the Cochrane Collaboration do not provide for systematic reviews of causation, yet this information is important in clinical practice when trying to reach a diagnosis.

There is also a need to do an up to date prospective, population based study of sudden and severe headache with a specific emphasis on identifying the frequency of vasoconstriction syndromes, the long term prognosis of cases in whom aneurysmal subarachnoid haemorrhage is excluded, and examining cases where a clinical diagnosis remains elusive, even after examination by a neurologist.

Conclusions

This paper presents what we regard as a definitive list of associations of Sudden and Severe Headache. This list is important as it demonstrates that the differential diagnosis of sudden and severe headache is substantial. Our review confirms that a wide range of diseases and provoking circumstances are associated with sudden and severe headache, specifically, haemorrhage, thrombosis, dissection, arterial expansion, extremes of intracranial pressure, infection, inflammation and even intracranial air. In large unselected cohorts the majority of cases are assigned a primary headache diagnosis or have a cause of headache that does not meet any specific diagnostic criteria.

New cases of sudden and severe headache associated with conditions which are not represented in our list should be considered for publication in the medical literature as novel causes.

Competing interests

RF has received unrestricted educational grants to fund attendance at European Neurological Society meeting in Athens 2004 (value <1000GBP), The International Headache Society Meeting in Stockholm 2007 (value <1000GBP)

and The American Headache Society Meeting Boston June 2008 (value <2000GBP), The EHMTIC meeting London 2012 (value <1000GBP) from Janssen-Cilag and Allergan pharmaceutical companies. The Neurology Department in which RF practices received an unrestricted educational grant from Cyberonics for an economic analysis of vagus nerve stimulators in 2007 (value 7000GBP). RF has received an honorarium for contributions at an educational meeting sponsored by Allergan in Dublin November 2013 (1065GBP). RF runs a website called severe-headache-expert.com which earns income from advertising. HN no conflicts of interest. ED no conflicts of interest.

Authors' contributions

RF initiated and designed the review, screened the articles, assisted with data abstraction, data analysis, co-wrote and edited and approved the final manuscript, and is ultimately accountable for this work. HN designed the systematic review and obtained articles from external sources. ED abstracted data from identified articles, summarized and analysed data, wrote initial version of manuscript and approved final version for submission. All authors read and approved the final manuscript.

Funding source

The Southern HSC Trust awarded a grant of 1000GBP towards publication costs.

Received: 17 April 2014 Accepted: 3 June 2014

Published: 14 August 2014

References

- Craig JJ, Patterson VH (1997) Headaches in the accident and emergency department. *Br J Hosp Med* 57:202–206
- Edlow JA, Caplan LR (2000) Avoiding pitfalls in the diagnosis of subarachnoid hemorrhage. [see comment]. *N Engl J Med* 342:29–36
- Schwedt TJ, Matharu MS, Dodick DW (2006) Thunderclap headache. *Lancet Neurol* 5:621–631
- Matharu MS, Schwedt TJ, Dodick DW (2007) Thunderclap headache: an approach to a neurologic emergency. *Curr Neurol Neurosci Rep* 7:101–109
- Schwedt TJ (2007) Clinical spectrum of thunderclap headache. *Expert Rev Neurother* 7:1135–1144
- Dodick DW (2002) Thunderclap headache. *J Neurol Neurosurg Psychiatry* 72:6–11
- Dodick DW (2002) Thunderclap headache. *Headache* 42:309–315
- Davenport R (2002) Acute headache in the emergency department. [see comment]. *J Neurol Neurosurg Psychiatry* 72(Suppl 2):ii33–ii37
- Davenport R (2004) Diagnosing acute headache. [see comment]. *Clin Med* 4:108–112
- National Library of Medicine (2013) Medical Subject Headings Expanded Database. [27th December 2013]. Available from: http://www.nlm.nih.gov/cgi/mesh/2014/MB_cgi?mode=&index=23330&view=expanded
- Pearce JM (1988) Exploding head syndrome. *Lancet* 2(8605):270–271
- Raskin NH, Schwartz RK (1980) Icepick-like pain. *Neurology* 30(2):203–205
- Gronseth G, Cruccu G, Alksne J, Argoff C, Brainin M, Burchiel K, Nurmikko T, Zakrzewska JM, et al. (2008) Practice parameter: the diagnostic evaluation and treatment of trigeminal neuralgia (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology and the European Federation of Neurological Societies. *Neurology* 71(15):1183–1190
- Silberstein SD, Olesen J, Boussier MG, Diener HC, Dodick DW, First M, Goadsby PJ, Gobet H, Lainez MJ, Lance JW, Lipton RB, Nappi G, Sakai F, Schoenen J, Steiner TJ (2005) The International Classification of Headache Disorders, 2nd Edition (ICHD-II)—revision of criteria for 8.2 Medication-overuse headache. *Cephalalgia* 25(6):460–465
- Google (2013) Google Translate. [27th December 2013]. Available from: <http://translate.google.com/#auto/en/>
- Hook EB, Regal RR (1995) Capture-recapture methods in epidemiology: methods and limitations. *Epidemiol Rev* 17(2):243–264
- Landtblom A-M, Fridriksson S, Boivie J, Hillman J, Johansson G, Johansson I (2002) Sudden onset headache: a prospective study of features, incidence and causes. *Cephalalgia* 22:354–360
- Linn FHH, Wijdicks EFM (2002) Causes and management of thunderclap headache: a comprehensive review. *Neurologist* 8:279–289
- Moussouttas M, Mayer SA (2008) Thunderclap headache with normal CT and lumbar puncture: further investigations are unnecessary: against. [comment]. *Stroke* 39:1394–1395
- Boivie J (1991) Thunderclap headache—scary and alarming. *Lakartidningen* 88(25):2312–2314
- Ducros A (2005) Thunderclap headache. *Rev Neurol (Paris)* 16(6–7):713–715
- Kerkhoff H, Wijdicks EF, van Gijn J (1989) Headache like a thunderclap in a clear sky: subarachnoid bleeding or harmless disorder? *Ned Tijdschr Geneesk* 133:1881–1883
- Sturzenegger M (1993) Acute headache. *Schweiz Med Wochenschr* 123:789–799
- Mumenthaler M (1997) The dangerous headache. *Ther Umsch* 54:79–82
- Gauvrit JY, Leclerc X, Moulin T, Oppenheim C, Savage J, Pruvo JP, Meder JF (2004) Headaches in the emergency context. *J Neuroradiol* 31:262–270
- Wang WW, Lin C-S (2008) Headache angina. *Am J Emerg Med* 26:387.e1–e2
- Bo SH, Davidsen EM, Gulbrandsen P, Dietrichs E (2008) Acute headache: a prospective diagnostic work-up of patients admitted to a general hospital. *Eur J Neurol* 15:1293–1299
- Linn FH, Wijdicks EF, van der Graaf Y, Weerdesteyn-van V, Bartelds AI, van Gijn J (1994) Prospective study of sentinel headache in aneurysmal subarachnoid haemorrhage. *Lancet* 344:590–593
- Ahmad A, Khan P, Ahmad K, Syed A (2008) Diagnostic outcome of patients presenting with severe thunderclap headache at Saidu Teaching Hospital. *Pakistan J Med Sci* 24:575–580
- Singhal AB (2004) Cerebral vasoconstriction syndromes. *Topics in Stroke Rehabilitation* 11:1–6
- Perry JJ, Stiell IG, Wells GA, Mortensen M, Lesiuk H, Sivilotti M, Kapur A (2005) Attitudes and judgment of emergency physicians in the management of patients with acute headache. *Acad Emerg Med* 12:33–37
- Wang SJ, Fuh JL, Wu ZA, Chen SP, Lirng JF (2008) Bath-related thunderclap headache: a study of 21 consecutive patients. *Cephalalgia* 28:524–530
- Dodick DW, Wijdicks EF (1998) Pituitary apoplexy presenting as a thunderclap headache. *Neurology* 50:1510–1511
- Pascual-Leone A, Pascual-Leone P (1992) Occipital neuralgia: another benign cause of "thunderclap headache". *J Neurol Neurosurg Psychiatry* 55:411
- Raps EC, Rogers JD, Galetta SL, Solomon RA, Lennihan L, Klebanoff LM, Fink ME (1993) The clinical spectrum of unruptured intracranial aneurysms. [see comment]. *Arch Neurol* 50:265–268
- Liao YC, Fuh JL, Lirng JF, Lu SR, Wu ZA, Wang SJ (2003) Bathing headache: a variant of idiopathic thunderclap headache. *Cephalalgia* 23(9):854–859
- Mak W, Tsang KL, Tsoi TH, Au Yeung KM, Chan KH, Cheng TS, Cheung TFR, Ho SL (2005) Bath-related headache. *Cephalalgia* 25:191–198
- Negoro K, Morimatsu M, Ikuta N, Nogaki H (2000) Benign hot bath-related headache. *Headache* 40:173–175
- Rossi P, Nappi G (2006) Bath-related headache: the first European case. *Cephalalgia* 26:1485–1486
- Tanaka M, Okamoto K (2007) Bath-related headache: a case report. *Cephalalgia* 27:563–565
- Ibbotson SH (1987) Weight-lifter's headache. *Br J Sports Med* 21:138
- Powell B (1982) Weight lifter's cephalgia. *Ann Emerg Med* 11:449–451
- Imperato J, Burstein J, Edlow JA (2003) Benign exertional headache. *Ann Emerg Med* 41:98–103
- Nassar L, Albano J, Padron D (1999) Exertional headache in a collegiate gymnast. *Clin J Sport Med* 9:182–183
- Massey EW (1982) Effort headache in runners. *Headache* 22:99–100
- Kim JS (1992) Swimming headache followed by exertional and coital headaches. *J Korean Med Sci* 7:276–279
- Kim YI, Lee SJ, Lee KS, Park JW, Kim JS (2008) Recurrent thunderclap headache triggered by singing. *Eur J Neurol* 15:e116–e117
- Clarke C, Shepherd D, Chisti K, Victoratos G (1988) Thunderclap headache. *Lancet* 2:625
- Lu S, Liao Y, Fuh J, Lirng J-F, Wang S-J (2004) Nimodipine for treatment of primary thunderclap headache. *Neurology* 62:1414–1416
- Markus HS (1991) A prospective follow up of thunderclap headache mimicking subarachnoid haemorrhage. *J Neurol Neurosurg Psychiatry* 54:1117–1118
- Lance JW (1974) Headaches occurring during sexual intercourse. *Proc Aust Assoc Neurol* 11:57–60
- Katchen MS (1990) Exertional headaches with multiple triggers. *Aviat Space Environ Med* 61:49–51
- Frese A, Rahmann A, Gregor N, Biehl K, Husstedt IW, Evers S (2007) Headache associated with sexual activity: prognosis and treatment options. *Cephalalgia* 27:1265–1270

54. Porter M, Jankovic J (1981) Benign coital cephalalgia. Differential diagnosis and treatment. *Arch Neurol* 38:710–712
55. Kim H-J, Seo S-Y (2008) Recurrent emotion-triggered headache following primary headache associated with sexual activity. *J Neurol Sci* 273:142–143
56. Anand KS, Dhikav V (2009) Primary headache associated with sexual activity. *Singapore Med J* 50(5):e176–e177
57. Johns DR (1986) Benign sexual headache within a family. *Arch Neurol* 43:1158–1160
58. Lewis GN (1976) Orgasm headaches. *J Indiana State Med Assoc* 69:785–788
59. Martin EA (1974) Headache during sexual intercourse (coital cephalalgia). A report on six cases. *Ir J Med Sci* 143:342–345
60. Martinez JM, Roig C, Arboix A (1988) Complicated coital cephalalgia. Three cases with benign evolution. *Cephalalgia* 8:265–268
61. Nutt NR (1977) Sexually induced headaches. *Br Med J* 1:1664
62. Paulson GW, Klawans HL, Jr (1974) Benign orgasmic cephalgia. *Headache* 13(4):181–187
63. Selekler M, Kutlu A, Dundar G (2009) Orgasmic headache responsive to greater occipital nerve blockade. *Headache* 49:130–131
64. Ostergaard JR, Kraft M (1992) Benign coital headache. [see comment]. *Cephalalgia* 12:353–355
65. Lerner AJ (2006) Late presentation of primary headache associated with sexual activity: is non-invasive angiography worthwhile? *J Headache Pain* 7:139–140
66. Edis RH, Silbert PL (1988) Sequential benign sexual headache and exertional headache. *Lancet* 1:993
67. Heckmann JG, Hilz MJ, Muck-Weymann M, Neundorfer B (1997) Benign exertional headache/benign sexual headache: a disorder of myogenic cerebrovascular autoregulation? *Headache* 37:597–598
68. Woessner R, Grauer MT, Langenbach J, Dobler G, Kroeger J, Mielke HG, Mueller P, Haass A, Treib J (2000) The Erve virus: possible mode of transmission and reservoir. *Infection* 28:164–166
69. Lledo A, Calandre L, Martinez-Menendez B, Perez-Sempere A, Portera-Sanchez A (1994) Acute headache of recent onset and subarachnoid hemorrhage: a prospective study. [see comment]. *Headache* 34:172–174
70. Lamonte M, Silberstein SD, Marcelis JF (1995) Headache associated with aseptic meningitis. *Headache* 35:520–526
71. Treib J, Dobler G, Haass A, von Blohn W, Strittmatter M, Pindur, Froesner GG, Schimrigk K (1998) Thunderclap headache caused by Erve virus? *Neurology* 50:509–511
72. Anonymous (1996) Case records of the Massachusetts General Hospital. Weekly clinicopathological exercises. Case 38–1996. An 18-year-old man with severe headache, pleocytosis, and ataxia. *N Engl J Med* 335:1829–1834
73. Schwartz MD, Shaw GJ (2002) Bacterial meningitis secondary to a transthemoidal encephalocele presenting to the emergency department. *J Emerg Med* 23(2):171–174
74. Basilio-de-Oliveira CA, Aguiar GR, Baldanza MS, Barth OM, Eyer-Silva WA, Paes MV (2005) Pathologic study of a fatal case of dengue-3 virus infection in Rio de Janeiro, Brazil. *Braz J Infect Dis* 9:341–347
75. Hosley C, Ward T (2008) Teaching case—headache in the emergency room: a review. *Headache* 48:988–990
76. Garza I, Black DF (2006) Persistent primary thunderclap headache responsive to gabapentin. *J Headache Pain* 7:419–421
77. Jacobi C, Schwark C, Kress B, Hug A, Storch-Hagenlocher B, Schwaninger M (2006) Subarachnoid hemorrhage due to *Borrelia burgdorferi*-associated vasculitis. *Eur J Neurol* 13:536–538
78. McGeeney BE, Barest G, Grillone G (2006) Thunderclap headache from complicated sinusitis. *Headache* 46:517–520
79. Chalaupka F, Caneve G, Mauri M, Zaiotti G (2007) Thunderclap headache caused by minimally invasive medical procedures: description of 2 cases. *Headache* 47:293–295
80. Botez SA (2007) Headache and cerebral venous air embolism. *Neurology* 68:19
81. Hughes RL (1992) Identification and treatment of cerebral aneurysms after sentinel headache. *Neurology* 42:1118–1119
82. Witham TF, Kaufmann AM (2000) Unruptured cerebral aneurysm producing a thunderclap headache. *Am J Emerg Med* 18:88–90
83. Markwalder TM, Meienberg O (1983) Acute painful cavernous sinus syndrome in unruptured intracavernous aneurysms of the internal carotid artery. Possible pathogenetic mechanisms. *J Clin Neuroophthalmol* 3:31–35
84. Byrum E, McGregor J, Christiforidis G (2009) Thunderclap headache without subarachnoid hemorrhage associated with regrowth of previously coil-occluded aneurysms. *Am J Neuroradiol* 30:1059–1061
85. Svenson J, Cowen D, Rogers A (1997) Headache in the emergency department: importance of history in identifying secondary etiologies. *J Emerg Med* 15:617–621
86. Anonymous (2002) Aneurysmal "thunderclap" headache without subarachnoid hemorrhage. *Headache* 42(1):82
87. Locatelli M, Spagnoli D, Caroli M, Isalberti M, Branca V, Gaini SM, Lania A (2008) A potential catastrophic trap: an unusually presenting sellar lesion. *Eur J Neurol* 15:98–101
88. Shibata T, Kubo M, Kuwayama N, Hirashima Y, Endo S (2006) Warning headache of subarachnoid hemorrhage and infarction due to vertebrobasilar artery dissection. *Clin J Pain* 22:193–196
89. Biousse V, Woimant F, Amarenco P, Touboul PJ, Bousser MG (1992) Pain as the only manifestation of internal carotid artery dissection. *Cephalalgia* 12:314–317
90. Cox LK, Bertorini T, Laster RE, Jr (1991) Headaches due to spontaneous internal carotid artery dissection magnetic resonance imaging evaluation and follow up. *Headache* 31:12–16
91. Fisher CM (1982) The headache and pain of spontaneous carotid dissection. *Headache* 22:60–65
92. Joo IS, Lee JS (2005) Dissecting aneurysm of the basilar artery as a cause of orgasmic headache. *Headache* 45:956–959
93. Arnold M, Camus-Jacqmin M, Stapf C, Ducros A, Viswanathan A, Berthet K, Bousser MG (2008) Postpartum cervicocephalic artery dissection. *Stroke* 39:2377–2379
94. Buyle M, Engelborghs S, Kunnen J, De Deyn PP (2001) Headache as only symptom in multiple cervical artery dissection. *Headache* 41:509–511
95. Gates J, Hartnell GG, Quintas J (1997) Young adult with "worst ever headache" following mild trauma. *Acad Radiol* 4:312–313
96. Szatmary Z, Boukobza M, Vahedi K, Stapf C, Houdart E, Bousser MG (2006) Orgasmic headache and middle cerebral artery dissection. *J Neurol Neurosurg Psychiatry* 77:693–694
97. Price L, Parghi C, Khan R (2007) Thunderclap headache—and a tender neck. *Lancet* 370:1974
98. Wijidicks EF, Schievink WI, Miller GM (1998) Pretruncal nonaneurysmal subarachnoid hemorrhage. *Mayo Clin Proc* 73:745–752
99. Refai D, Botros JA, Strom RG, Derdeyn CP, Sharma A, Zipfel GJ (2008) Spontaneous isolated convexity subarachnoid hemorrhage: presentation, radiological findings, differential diagnosis, and clinical course. *J Neurosurg* 109:1034–1041
100. Nakamura K, Saku Y, Ibayashi S, Fujishima M (1997) Simultaneous multiple brain hemorrhage associated with migraine: a case report. *Angiology* 48:551–555
101. Schievink WI, Thompson RC, Loh CT, Maya MM (2001) Spontaneous retroclival hematoma presenting as a thunderclap headache. Case report *Journal of Neurosurgery* 95:522–524
102. Spitzer C, Mull M, Rohde V, Kosinski CM (2005) Non-traumatic cortical subarachnoid haemorrhage: diagnostic work-up and aetiological background. *Neuroradiology* 47:525–531
103. Jung T-Y, Jung S, Lee M-C, Moon K-S, Kim I-Y, Kang S-S, Kim SH (2006) Hemorrhagic intracranial inflammatory pseudotumor originating from the trigeminal nerve: a case report. *Journal of Neuro Oncology* 76:139–142
104. Alvarez-Cermeno JC, Martinez-Castrillo JC, Gobernado JM (1988) Sudden headache associated with unilateral asterixis. *Headache* 28:352–353
105. Fracasso T, Brinkmann B, Paulus W (2008) Sudden death due to subarachnoid bleeding from echordosis physaliphora. *Int J Legal Med* 122:225–227
106. Jones LK, Flemming KD (2005) Headache and diffuse subarachnoid hyperdensity on head CT following thoracic epidural blood patch. *Headache* 45:951–953
107. Luda E, Comitangelo R, Sicuro L (1995) The symptom of headache in emergency departments. The experience of a neurology emergency department. *Ital J Neurol Sci* 16:295–301
108. Schievink WI, Wijidicks EF, Spetzler RF (2000) Diffuse vasospasm after pretruncal nonaneurysmal subarachnoid hemorrhage. *AJNR Am J Neuroradiol* 21:521–523
109. Edwards MJ, Walker R, Vinnicombe S, Barlow C, MacCallum P, Foran JM (2001) Reversible posterior leukoencephalopathy syndrome following CHOP chemotherapy for diffuse large B-cell lymphoma. *Ann Oncol* 12:1327–1329
110. Bridgman J, Witting M (1996) Thrombotic thrombocytopenic purpura presenting as a sudden headache with focal neurologic findings. *Ann Emerg Med* 27:95–97

111. Tang-Wai DF, Phan TG, Wijdicks EF (2001) Hypertensive encephalopathy presenting with thunderclap headache. *Headache* 41:198–200
112. Sutton-Brown M, Morrish W, Zochodne DW (2006) Recurrent coital 'thunderclap' headache associated with ischaemic stroke. *Cephalalgia* 26:1028–1030
113. Schwedt TJ, Dodick DW (2006) Thunderclap stroke: embolic cerebellar infarcts presenting as thunderclap headache. *Headache* 46:520–522
114. Annic A, Lucas C (2007) Ischemic stroke revealed by a thunderclap headache: contribution of diffusion-weighted mri sequences. *Rev Neurol* 163:599–601
115. Edvardsson BA, Persson S (2009) Cerebral infarct presenting with thunderclap headache. *J Headache Pain* 10:207–209
116. Alvaro LC, Iriondo I, Villaverde FJ (2002) Sexual headache and stroke in a heavy cannabis smoker. *Headache* 42:224–226
117. de Sousa JE, Halfon MJ, Bonardo P, Reisin RC, Fernandez Pardal MM (2005) Different pain patterns in patients with vertebral artery dissections. *Neurology* 64:925–926
118. Kawanishi M, Sakaguchi I, Miyake H (2003) Occlusion of the posterior communicating artery mimicking cerebral aneurysm: case report. *Neurol Res* 25:543–545
119. Crane R, Kerr LD, Spiera H (1991) Clinical analysis of isolated angiitis of the central nervous system. A report of 11 cases. [see comment]. *Arch Intern Med* 151:2290–2294
120. Cupps TR, Moore PM, Fauci AS (1983) Isolated angiitis of the central nervous system. Prospective diagnostic and therapeutic experience. *Am J Med* 74(1):97–105
121. Cho JH, Ahn JY, Byeon SH, Huh JS (2008) Thunderclap headache as initial manifestation of Vogt-Koyanagi-Harada disease. *Headache* 48:153–155
122. Tavsanli M, Uluduz D, Saip S, Kendiroglu G (2008) Vogt-Koyanagi-Harada disease: headache as an initial manifestation. *J Headache Pain* 9(4):255–256
123. Santos E, Zhang Y, Wilkins A, Renowden S, Scolding N (2009) Reversible cerebral vasoconstriction syndrome presenting with haemorrhage. *J Neurol Sci* 276:189–192
124. Widjaja E, Romanowski CAJ, Sinanan AR, Hodgson TJ, Griffiths PD (2003) Thunderclap headache: presentation of intracranial sinus thrombosis? *Clin Radiol* 58:648–652
125. Gladstone JP, Dodick DW, Evans R (2005) The young woman with postpartum "thunderclap" headache. *Headache* 45:70–74
126. Jaiser SR, Raman A, Maddison P (2008) Cerebral venous sinus thrombosis as a rare cause of thunderclap headache and nonaneurysmal subarachnoid haemorrhage. *J Neurol* 255:448–449
127. Cortez O, Schaeffer CJ, Hatem SF, Glauser J, Ahmed M (2009) Cases from the Cleveland Clinic: cerebral venous sinus thrombosis presenting to the emergency department with worst headache of life. *Emerg Radiol* 16:79–82
128. de Bruijn SF, Stam J, Kappelle LJ (1996) Thunderclap headache as first symptom of cerebral venous sinus thrombosis. *CVST Study Group Lancet* 348(9042):1623–1625
129. McDonnell M, El-Bialy A (2008) The ache of a beating heart. *Am J Med* 121:956–959
130. Dodick DW, Eross EJ (2002) A not so uncommon cause of thunderclap headache. *Headache* 42:555
131. Weidauer S, Marquardt G, Seifert V, Zanella FE (2005) Hydrocephalus due to superior sagittal sinus thrombosis. *Acta Neurochir* 147:427–430. discussion 30
132. Chen S-P, Fuh J-L, Chang F-C, Lirng J-F, Shia B-C, Wang S-J (2008) Transcranial color doppler study for reversible cerebral vasoconstriction syndromes. *Ann Neurol* 63:751–757
133. Ducros A, Boukoba M, Porcher R, Sarov M, Valade D, Bousser MG (2007) The clinical and radiological spectrum of reversible cerebral vasoconstriction syndrome. A prospective series of 67 patients. *Brain* 130(Pt 12):3091–3101
134. Chen SP, Fuh JL, Lirng JF, Chang FC, Wang SJ (2006) Recurrent primary thunderclap headache and benign CNS angiopathy: spectra of the same disorder? *Neurology* 67(12):2164–2169
135. Koopman K, Teune LK, ter Laan M, Uyttenboogaart M, Vroomen PC, Keyser J, Lujckx GJ (2008) An often unrecognized cause of thunderclap headache: reversible cerebral vasoconstriction syndrome. *J Headache Pain* 9:389–391
136. Sharma P, Poppe AY, Eesa M, Steffenhagen N, Goyal M (2008) Postpartum thunderclap headache. *Cmaj* 179:1033–1035
137. Koopman K, Uyttenboogaart M, Lujckx GJ, De Keyser J, Vroomen PCAJ (2007) Pitfalls in the diagnosis of reversible cerebral vasoconstriction syndrome and primary angiitis of the central nervous system. *Eur J Neurol* 14:1085–1087
138. Nowak DA, Rodiek SO, Henneken S, Zinner J, Schreiner R, Fuchs HH, Topka H (2003) Reversible segmental cerebral vasoconstriction (Call-Fleming syndrome): are calcium channel inhibitors a potential treatment option? *Cephalalgia* 23(3):218–222
139. Kirton A, Diggle J, Hu W, Wirrell E (2006) A pediatric case of reversible segmental cerebral vasoconstriction. *Can J Neurol Sci* 33:250–253
140. Nickele C, Muro K, Getch CC, Walker MT, Bernstein RA (2007) Severe reversible cerebral vasoconstriction syndrome mimicking aneurysmal rupture and vasospasm. *Neurocrit Care* 7:81–85
141. Keyrouz S, Dhar R, Axelrod Y (2008) Call-Fleming syndrome and orgasmic cephalgia. *Headache* 48:967–971
142. Elstner M, Linn J, Muller-Schunk S, Straube A (2009) Reversible cerebral vasoconstriction syndrome: a complicated clinical course treated with intra-arterial application of nimodipine. *Cephalalgia* 29:677–682
143. Saini M, Jeerakathil T, Butcher K (2009) Reversible cerebral vasoconstriction syndrome. *Neurol India* 57:63–65
144. Bouchard M, Verreault S, Garipey J-L, Dupre N (2009) Intra-arterial milrinone for reversible cerebral vasoconstriction syndrome. *Headache* 49:142–145
145. Wong SH, Dougan C, Chatterjee K, Fletcher NA, White RP (2009) Recurrent thunderclap headaches and multilobar intracerebral haemorrhages: two cases of reversible cerebral vasoconstriction syndrome (RCVS). *Cephalalgia* 29:791–795
146. Oz O, Demirkaya S, Bek S, Eroglu E, Ulas U, Odabasi Z (2009) Reversible cerebral vasoconstriction syndrome: case report. *J Headache Pain* 10:295–298
147. Call GK, Fleming MC, Sealfon S, Levine H, Kistler JP, Fisher CM (1988) Reversible cerebral segmental vasoconstriction. *Stroke* 19:1159–1170
148. Whyte CA, Calabrese LH (2009) Reversible cerebral vasoconstriction syndrome. *Headache* 49:597–598
149. Zuber M, Touze E, Domigo V, Trystram D, Lamy C, Mas J-L (2006) Reversible cerebral angiopathy: efficacy of nimodipine. *J Neurol* 253:1585–1588
150. Edlow BL, Kasner SE, Hurst RW, Weigele JB, Levine JM (2007) Reversible cerebral vasoconstriction syndrome associated with subarachnoid hemorrhage. *Neurocrit Care* 7:203–210
151. Singhal AB (2004) Postpartum angiopathy with reversible posterior leukoencephalopathy. *Arch Neurol* 61:411–416
152. Slivka A, Philbrook B (1995) Clinical and angiographic features of thunderclap headache. *Headache* 35:1–6
153. Singhal AB, Caviness VS, Begleiter AF, Mark EJ, Rordorf G, Koroshetz WJ (2002) Cerebral vasoconstriction and stroke after use of serotonergic drugs. *Neurology* 58:130–133
154. Dodick D, Brown R, Jr, Britton J, Huston J, III (1999) Nonaneurysmal thunderclap headache with diffuse, multifocal, segmental, and reversible vasospasm. *Cephalalgia* 19:118–123
155. Levy RL (1981) Stroke and orgasmic cephalgia. *Headache* 21:12–13
156. Jackson M, Lennox G, Jaspan T, Jefferson D (1993) Migraine angiitis precipitated by sex headache and leading to watershed infarction. *Cephalalgia* 13:427–430
157. Meschia JF, Malkoff MD, Biller J (1998) Reversible segmental cerebral arterial vasospasm and cerebral infarction: possible association with excessive use of sumatriptan and Midrin. *Arch Neurol* 55:712–714
158. Sturm JW, Macdonell RA (2000) Recurrent thunderclap headache associated with reversible intracerebral vasospasm causing stroke. [see comment]. *Cephalalgia* 20:132–135
159. Heckmann JG, Tomandi B, Kraus B, Gerlach R, Neundorfer B (2000) A case of diffuse cerebral vasospasm - Possibly ergotamine-associated? *Cerebrovasc Dis* 10:417–418
160. Dodick DW, Eross EJ, Drazkowski JF, Ingall TJ (2003) Thunderclap headache associated with reversible vasospasm and posterior leukoencephalopathy syndrome. *Cephalalgia* 23(10):994–997
161. Bartynski WS, Sanghvi A (2003) Neuroimaging of delayed eclampsia: report of 3 cases and review of the literature. *J Comput Assist Tomogr* 27:699–713
162. Foxford RJ, Sahlas DJ, Wingfield KA (2003) Vasospasm-induced stroke in a varsity athlete secondary to ephedrine ingestion. *Clin J Sport Med* 13:183–185
163. Lupo I, Saia V, Cammarata E, Giglia G, Palermo A, Mangiapane P (2004) Thunderclap headache and reversible posterior leukoencephalopathy: case report. *Acta Medica Mediterranea* 20:123–126
164. Schlegel D, Cucchiara B (2004) Orgasmic headache with transient basilar artery vasospasm. *Headache* 44:710–712
165. Valenca MM, Valenca LPAA, Bordini CA, da Silva WF, Leite JP, Antunes-Rodrigues J, Speciali JG (2004) Cerebral vasospasm and headache during sexual intercourse and masturbatory orgasms. *Headache* 44:244–248

166. Renard D (2006) Cerebral vasospasm in idiopathic thunderclap headache. *Neurology* 67:990
167. Neudecker S, Stock K, Krasnianski M (2006) Call-Fleming postpartum angiopathy in the puerperium: a reversible cerebral vasoconstriction syndrome. [see comment]. *Obstet Gynecol* 107:446–449
168. Chen S-P, Fuh J-L, Lirng J-F, Wang S-J (2006) Is vasospasm requisite for posterior leukoencephalopathy in patients with primary thunderclap headaches? *Cephalalgia* 26:530–536
169. Kocak A, Sarac K, Ates O, Cayli SR (2007) Severe cerebral vasospasm caused by non-aneurysmal subarachnoid hemorrhage treatment with transluminal balloon angioplasty. *Minim Invasive Neurosurg* 50:23–26
170. Shalchian S, de Wispelaere F (2007) Call-Fleming syndrome: another case report. *Headache* 47:909–910
171. Schievink WI, Maya MM, Chow W, Louy C (2007) Reversible cerebral vasoconstriction in spontaneous intracranial hypotension. *Headache* 47:284–287
172. Honma K, Takizawa S, Ohtomo T, Takagi S (2007) MR findings in Call-Fleming syndrome. *Intern Med* 46:539–540
173. Moskowitz SI, Calabrese LH, Weil RJ (2007) Benign angiopathy of the central nervous system presenting with intracerebral hemorrhage. *Surg Neurol* 67:522–527
174. Moustafa RR, Allen CMC, Baron J-C (2008) Call-Fleming syndrome associated with subarachnoid haemorrhage: three new cases. *J Neurol Neurosurg Psychiatry* 79:602–605
175. Ramnarayan R, Sriganesh J (2009) Postpartum cerebral angiopathy mimicking hypertensive putaminal hematoma: a case report. *Hypertens Pregnancy* 28:34–41
176. Day JW, Raskin NH (1986) Thunderclap headache: symptom of unruptured cerebral aneurysm. *Lancet* 2:1247–1248
177. Dhuna A, Pascual-Leone A, Belgrade M (1991) Cocaine-related vascular headaches. *J Neurol Neurosurg Psychiatry* 54:803–806
178. Gold KJ, Barnes C, Lalley J, Schwenk TL (2005) Case report: late-onset eclampsia presents as bilateral cortical blindness. *Am Fam Physician* 71:856
179. Hoffmann J, Harms L, Klingebiel R (2009) Neurological picture. Reversible cerebral vasoconstriction associated with orgasmic headache. *J Neurol Neurosurg Psychiatry* 80:959
180. Kiemeneij IM, de Leeuw FE, Ramos LMP, van Gijn J (2003) Acute headache as a presenting symptom of tacrolimus encephalopathy. *J Neurol Neurosurg Psychiatry* 74:1126–1127
181. Kubo S, Nakata H, Tatsumi T, Yoshimine T (2002) Headache associated with postpartum cerebral angiopathy: monitoring with transcranial color-coded sonography. *Headache* 42:297–300
182. Looi JL, Christiansen JP (2006) Reversible posterior leukoencephalopathy associated with minimal change nephrotic syndrome. *N Z Med J* 119:U2257
183. Modi M, Modi G (2000) Case reports: postpartum cerebral angiopathy in a patient with chronic migraine with aura. *Headache* 40:677–681
184. Moussouttas M, Abubakr A, Grewal RP, Papamitsakis N (2006) Eclamptic subarachnoid haemorrhage without hypertension. *J Clin Neurosci* 13:474–476
185. Parameswaran BK, Krishnan PR, Al DJ (2007) Recurrent posterior reversible encephalopathy syndrome in a patient with sickle cell disease. *Ann Saudi Med* 27:206–211
186. Rosenbloom MH, Singhal AB (2007) CT angiography and diffusion-perfusion MR imaging in a patient with ipsilateral reversible cerebral vasoconstriction after carotid endarterectomy. *AJNR Am J Neuroradiol* 28:920–922
187. Silbert PL, Hankey GJ, Prentice DA, Apsimon HT (1989) Angiographically demonstrated arterial spasm in a case of benign sexual headache and benign exertional headache. *Aust N Z J Med* 19:466–468
188. Loewen AHS, Hudon ME, Hill MD (2004) Thunderclap headache and reversible segmental cerebral vasoconstriction associated with use of oxymetazoline nasal spray. *Can Med Assoc J* 171:593–594
189. Schievink WI, Wijdicks EFM, Meyer FB, Sonntag VKH, Barrow DL, Mayberg MR, Fleetwood IG, Steinberg GK, Weir BKA (2001) Spontaneous intracranial hypotension mimicking aneurysmal subarachnoid hemorrhage. *Neurosurgery* 48:513–517
190. Kuo M-Y, Lien W-C, Wang H-P, Chen W-J (2005) Nontraumatic tension pneumocephalus—a differential diagnosis of headache at the ED. *Am J Emerg Med* 23:235–236
191. Evans RW (2007) Thunderclap headache associated with a nonhemorrhagic anaplastic oligodendroglioma. *MedGenMed* 9:26
192. Young WB, Silberstein SD (1997) Paroxysmal headache caused by colloid cyst of the third ventricle: case report and review of the literature. *Headache* 37:15–20
193. Jacome DE (2001) Transitional interpersonality thunderclap headache. *Headache* 41:317–320
194. Bhattacharyya N, Friedlander RM (2007) Pneumocephalus associated with pneumosinus dilatans frontalis. *N Engl J Med* 357:1136
195. Becker WJ (2002) Pneumocephalus as a cause for headache. *Can J Neurol Sci* 29:278–281
196. Hawley JS, Ney JP, Swanberg MM (2005) Subarachnoid pneumocephalus from epidural steroid injection. *Headache* 45:247–248
197. Krisanda TJ, Laucks SO (1994) Pneumocephalus following an epidural blood patch procedure: an unusual cause of severe headache. *Ann Emerg Med* 23:129–131
198. Laviola S, Kirvela M, Spoto MR, Tschuur S, Alon E (1999) Pneumocephalus with intense headache and unilateral pupillary dilatation after accidental dural puncture during epidural anesthesia for cesarean section. *Anesth Analg* 88:582–583
199. Smarkusky L, DeCarvalho H, Bermudez A, Gonzalez-Quintero VH (2006) Acute onset headache complicating labor epidural caused by intrapartum pneumocephalus. *Obstet Gynecol* 108:795–798
200. Asakura H, Hayashi Z, Seto M, Araki T (2001) Spontaneous intracranial hypotension during pregnancy. *Obstet Gynecol* 97:804–805
201. Broadley SA, Park N, Renowden S, Ferguson IT (2005) Unusual cause of sudden onset headache: spontaneous intracranial hypotension. *Emerg Med Australas* 17:520–523
202. Vaidhyanath R, Kenningham R, Khan A, Messios N (2007) Spontaneous intracranial hypotension: a cause of severe acute headache. *Emerg Med J* 24:739–741
203. Balgera R, Rigamonti A, Sozzi G, Agostoni E (2009) An atypical case of spontaneous intracranial hypotension. *Neurol Sci* 30:71–73
204. Ferrante E, Savino A (2005) Thunderclap headache caused by spontaneous intracranial hypotension. *Neurol Sci* 26:S155–S157
205. Famularo G, Minisola G, Gigli R (2005) Thunderclap headache and spontaneous intracranial hypotension. [comment]. *Headache* 45:392–393. author reply 3
206. Wang S-J, Fuh J-L (2005) Exertional but not postural headache resulting from spontaneous intracranial hypotension. *Acta Neurol Taiwan* 14:36–37
207. Buttner A, Winkler PA, Eisenmenger W, Weis S (1997) Colloid cysts of the third ventricle with fatal outcome: a report of two cases and review of the literature. *Int J Legal Med* 110:260–266
208. Mucchiut M, Valentinis L, Tuniz F, Zanotti B, Skrap M, Bergonzi P, Zanchin G (2007) Adult aqueductal stenosis presenting as a thunderclap headache: a case report. *Cephalalgia* 27:1171–1173
209. Lasoasa DS (2003) Not-so-benign sexual headache. *Headache* 43:808
210. Reeder JD, Wolf J, Andelman S, Andrew BJ (1990) The cough/laugh syndrome: MR evaluation. *AJNR Am J Neuroradiol* 11:1022
211. Titlic M, Jukic I, Kolic K, Rogosic V, Josipovic-Jelic Z (2008) An acute headache and hydrocephalus caused by the dermoid cyst. *Bratisl Lek Listy* 109:580–581
212. Galer BS, Lipton RB, Weinstein S, Bello L, Solomon S (1990) Apoplectic headache and oculomotor nerve palsy: an unusual presentation of multiple sclerosis. [see comment]. *Neurology* 40:1465–1466
213. Nishioka H, Ito H, Miki T, Hashimoto T, Nojima H, Matsumura H (1999) Rathke's cleft cyst with pituitary apoplexy: case report. *Neuroradiology* 41:832–834
214. Nishioka H, Haraoka J, Izawa H, Ikeda Y (2006) Headaches associated with Rathke's cleft cyst. *Headache* 46:1580–1586
215. Altay H, Kitis O, Calli C, Yuntun N (2006) A spinal dermoid tumor that ruptured into the subarachnoidal space and syrinx cavity. *Diagn Interv Radiol* 12:171–173
216. Cayli SR (2000) Arachnoid cyst with spontaneous rupture into the subdural space. *Br J Neurosurg* 14:568–570
217. Rozen TD (2002) Thunderclap headache with diplopia and anorexia. *Neurology* 59:461
218. Cryer RJ, Ferriman D (1971) Pituitary apoplexy. *Proc R Soc Med* 64:301–302
219. Garza I, Kirsch J (2007) Pituitary apoplexy and thunderclap headache. *Headache* 47:431–432
220. Epstein S, Pimstone BL, De Villiers JC, Jackson WP (1971) Pituitary apoplexy in five patients with pituitary tumours. *Br Med J* 2:267–270
221. Espinosa PS, Choudry B, Wilbourn R, Espinosa PH, Vaishnav AG (2007) Pituitary apoplexy: a neurological emergency case report. *J Ky Med Assoc* 105:538–540

222. Kuzma BB, Goodman JM (1999) Sudden headache with pituitary infarction. *Surg Neurol* 52:532–533
223. Markowitz S, Sherman L, Kolodny HD, Baruh S (1981) Acute pituitary vascular accident (pituitary apoplexy). *Med Clin N Am* 65:105–116
224. Sani S, Smith A, Leppä DL, Ilangoan S, Glick R (2005) Epidermoid cyst of the sphenoid sinus with extension into the sella turcica presenting as pituitary apoplexy: case report. *Surg Neurol* 63:394–397
225. Randeve HS, Schoebel J, Byrne J, Esiri M, Adams CB, Wass JA (1999) Classical pituitary apoplexy: clinical features, management and outcome. *Clin Endocrinol (Oxf)* 51:181–188
226. Hoff JJ, Bloem BR, Ferrari MD, Lammers GJ (2004) A breathtaking headache. [comment]. *J Neurol Neurosurg Psychiatry* 75:509
227. Amendo MT, Brown BA, Kossow LB, Weinberg FM (2001) Headache as the sole presentation of acute myocardial infarction in two elderly patients. *Am J Geriatr Cardiol* 10:100–101
228. Broner S, Lay C, Newman L, Swerdlow M (2007) Thunderclap headache as the presenting symptom of myocardial infarction. *Headache* 47:724–725
229. Seow V-K, Chong C-F, Wang T-L, Ong J-R (2007) Severe explosive headache: a sole presentation of acute myocardial infarction in a young man. *Am J Emerg Med* 25:250–251
230. Dalzell JR, Jackson CE, Robertson KE, McEntegart MB, Hogg KJ (2009) A case of the heart ruling the head: acute myocardial infarction presenting with thunderclap headache. *Resuscitation* 80:608–609
231. Lefkowitz D, Biller J (1982) Bregmatic headache as a manifestation of myocardial ischemia. *Arch Neurol* 39:130
232. Korantzopoulos P, Karanikis P, Pappa E, Dimitroula V, Kountouris E, Siogas K (2005) Acute non-ST-elevation myocardial infarction presented as occipital headache with impaired level of consciousness—a case report. *Angiology* 56:627–630
233. Nohe B, Ernemann U, Tepe G, Ritz R, Bail D (2005) Aortic dissection mimicking subarachnoidal hemorrhage. *Anesth Analg* 101:233–234
234. Singh S, Huang JY, Sin K, Charles RA (2007) Headache: an unusual presentation of aortic dissection. *Eur J Emerg Med* 14:47–49
235. Stollberger C, Finsterer J, Fousek C, Waldenberger FR, Haumer H, Lorenz W (1998) Headache as the initial manifestation of acute aortic dissection type A. *Cephalalgia* 18:583–584
236. Heo YE, Kwon HM, Nam HW (2009) Thunderclap headache as an initial manifestation of pheochromocytoma. *Cephalalgia* 29:388–390
237. Khan O, Williams G (1981) Micturition with headache: pheochromocytoma of the bladder. *Eur Urol* 7:112–114
238. Adinma JI (1994) Acute puerperal coital headache and hypertension. [see comment]. *Aust N Z J Obstet Gynaecol* 34:487–488
239. Nishimoto H, Ogasawara K, Miura K, Ohmama S, Kashimura H, Ogawa A (2005) Acute intracranial hypertension due to occlusion of the brachiocephalic vein in a patient undergoing hemodialysis. *Cerebrovasc Dis* 20:207–208
240. Biran I, Steiner I (2002) Coital headaches induced by amiodarone. *Neurology* 58:501–502
241. Straube A, Plendl H, Bruening R (2006) Idiopathic thunderclap headache: reversible vasospasm of the Arteria basilaris. *Nervenarzt* 77:1232–1234
242. Shimada J, Takeda N, Yamauchi S, Urushibara T, Kawaguchi H (2004) Reversible posterior leukoencephalopathy syndrome: experience in 3 cases. *No To Shinkei* 56(12):1036–1041
243. Schmidt D (1982) Coital headache. *Schweiz Med Wochenschr* 112(30):1068–1069
244. Santos S, Larrode-Pellicer P, Iniguez-Martinez C, Perez-Lazarro C, Claramonte M, Alberti-Gonzalez O, Martinez L (2006) Sexual headaches associated to an arachnoid cyst. *Rev Neurol* 42:381–382
245. Rubiera-Del Fueyo M, Molina-Cateriano CA, Arenillas-Lara JF, Pelayo-Vergara R, Santamarina E, Romero-Vidal FJ, Alvarez-Sabin J (2004) Reversible segmental cerebral vasoconstriction: the value of duplex transcranial doppler in its diagnosis and follow-up. *Rev Neurol* 38:530–533
246. Romero-Blanco M, Monteiro E, Joao G (2001) Sexual headache associated with intracranial tumour. *Rev Neurol* 33:100
247. Nicolle M, Hugues F (1981) A propos d'une cause rare de cephalée paroxystique, le kyste colloïde du troisième ventricule. *Semaine des Hopitaux Paris* 57:386–388
248. Ni J, Cui L-y (2009) Reversible cerebral vasoconstriction syndrome: one case report and review of the literature. *Chinese Journal of Contemporary Neurology and Neurosurgery* 9:31–34
249. Laubach S, Reber A (2004) Subarachnoid haemorrhage after spinal anaesthesia for caesarean section. *Anaesthetist* 53:723–726
250. Koga Y, Isobe N, Tateishi T, Osoegawa M, Ohyagi Y, Kira J (2008) Case of posterior reversible encephalopathy syndrome with cerebral vasoconstriction. *Rinsho Shinkeigaku* 48(5):355–358
251. Ichiki M, Watanabe O, Okamoto Y, Ikeda K, Takashima H, Arimura K (2008) A case of reversible cerebral vasoconstriction syndrome (RCVS) triggered by a Chinese herbal medicine. *Rinsho Shinkeigaku* 48(4):267–270
252. Hurtarte-Sandoval AR, Saenz-Alegria RA, Hernandez-Mejia J (2009) Reversible posterior leukoencephalopathy syndrome caused by pre-eclampsia. *Rev Neurol* 48:110–111
253. Hashimoto Y, Kaneko T, Morita E, Ohtaki M (2002) Serial magnetic resonance angiography in a case with isolated angiitis of the CNS. *No Shinkei Geka* 30:993–998
254. Hamasaki O, Sakamoto S, Nakahara T, Sakota K (2001) A case with diffuse vasospasm after perimesencephalic nonaneurysmal subarachnoid hemorrhage. *No To Shinkei* 53:1051–1055
255. Gossrau G, Dannenberg C, Reichmann H, Sabatowski R (2008) Thunderclap headache caused by cerebellar infarction. *Schmerz* 22(1):82–86
256. Gomez M, Aguirre J, Valverde-Grimaldi C, Berenguer A (1995) Sexual headache and cerebral hemorrhage. *Rev Neurol* 23:184–185
257. Gomez PA, Campollo J, Lobato RD, Lagares A, Alen JF (2001) Subarachnoid hemorrhage secondary to dissecting aneurysms of the vertebral artery. Description of 2 cases and review of the literature. *Neurocirugia (Astur)* 12(6):499–508
258. Garcia-Estevéz DA, Lopez-Real A (2008) Ischaemic stroke and sexual headache. *Rev Neurol* 47:108–109
259. Fuentes S, Metellus P, Adetchessi T, Dufour H, Grisoli F (2006) Idiopathic acute obstructive hydrocephalus. Case report. *Neurochirurgia* 52:47–51
260. Domitrl Z (2005) Primary headache associated with sexual activity. *Ginekol Pol* 76:995–999
261. Bogucki A, Niewodniczy A (1984) A case of headache occurring during sexual intercourse. *Pol Tyg Lek* 39(13):451–452
262. Bo SH, Rud EK, Kravdal GS (2005) Subarachnoidal haemorrhage with spectrophotometric detection of bilirubin in the spinal fluid as the only pathological result. *Tidsskrift for Den Norske Laegeforening* 125:2192–2194
263. Abenza Abildua MJ, Fuentes Martinez Sanchez B, Martinez Sanchez P (2009) Sudden headache after lumbar puncture: pneumoencephalus. *Neurologia* 24:79–80
264. Takeuchi T, Kasahara E, Iwasaki M, Higuchi M, Kojima S (1994) Necessity of cerebral angiography in thunderclap headache patients who show no evidence of subarachnoid hemorrhage: investigation of 350 cases. *No Shinkei Geka* 22:925–931
265. Takeuchi T, Kasahara E, Iwasaki M, Kojima S (1996) Necessity for searching for cerebral aneurysm in thunderclap headache patients who show no evidence of subarachnoid hemorrhage: investigation of 8 minor leak cases on operation. *No Shinkei Geka* 24:437–441
266. Salloom A, Lebel M, Reiher J (1977) Headache simulating meningeal hemorrhage. *Rev Neurol* 133:131–138
267. Rousseaux P, Scherpereel B, Bernard MH, Guyot JF (1983) Acute benign cerebral angiopathy. 6 cases. *Presse Med* 12:2163–2168
268. Nick J, Bakouche P (1980) Headache related to sexual intercourse (author's transl). *Semaine des Hopitaux* 56:621–628
269. Michel D, Vial C, Antoine JC, Laurent B, Portafaix M, Trillet M (1985) Benign acute cerebral angiopathy. 4 cases. *Rev Neurol* 141:786–792
270. Ito Z, Suzuki A, Nakajima K, Kutsusawa T (1976) Warning symptoms of rupture in cerebral aneurysm. *Nippon Rinsho* 34:123–130
271. Dimitrijevic J, Dzirlo K, Loncarevic N, Gordana B (2005) Acute strong headache in emergency neurology (diagnostic and treatment). *Med Arh* 59:102–105
272. Strittmatter M, Zimmermann C, Schimrigk K, Hamann GF (1996) Thunder clap headache: an independent form of headache? *Wien Klin Wochenschr* 108:326–329
273. Staszewski J, Kotowicz J (2004) Acute stroke or thunderclap headache? *Pol Merkur Lekarski* 16:539–542
274. Ekusheva EV, Filatova EG (2003) Headache caused by sexual activity. *Zh Nevrol Psikhiatr Im S S Korsakova* 103:21–25
275. Ducros A, Bousser MG (2013) Thunderclap headache. *BMJ* 346:e8557
276. Sattar A, Manousakis G, Jensen MB (2010) Systematic review of reversible cerebral vasoconstriction syndrome. *Expert Rev Cardiovasc Ther* 8(10):1417–1421
277. Sjaastad O, Bakkeiteig LS (2008) Prevalence of cervicogenic headache: a study of headache epidemiology. *Acta Neurol Scand* 117(3):173–180

278. Yeh YC, Fuh JL, Chen SP, Wang SJ (2010) Clinical features, imaging findings and outcomes of headache associated with sexual activity. *Cephalalgia* 30(11):1329–1335
279. Mathys J, Lachat M, Herren T (2004) Headache as a manifestation of a life-threatening vascular disorder. *Headache* 44:706–709
280. Ramaraj R (2008) Sudden onset of headache and recent breathlessness. *BMJ* 337:a1844
281. Takayanagi K, Fujito T, Morooka S, Takabatake Y, Nakamura Y (1990) Headache angina with fatal outcome. *Jpn Heart J* 31:503–507
282. Ishida A, Sunagawa O, Touma T, Shinzato Y, Kawazoe N, Fukiyama K (1996) Headache as a manifestation of myocardial infarction. *Jpn Heart J* 37:261–263
283. Greiner F, Rothrock J (2006) Thunderclap headache, cardiopulmonary arrest, and myocardial infarction. *Headache* 46:512
284. Calabrese LH, Dodick DW, Schwedt TJ, Singhal AB (2007) Narrative review: reversible cerebral vasoconstriction syndromes. *Ann Intern Med* 146:34–44
285. Sathirapanya P, Setthawatcharawanich S, Limapichat K, Phabphal K (2013) Thunderclap headache as a presentation of spontaneous spinal epidural hematoma with spontaneous recovery. *J Spinal Cord Med* 36(6):707–710
286. Verillaud B, Ducros A, Massiou H, Huy PT, Bousser MG, Herman P (2010) Reversible cerebral vasoconstriction syndrome in two patients with a carotid glomus tumour. *Cephalalgia* 30(10):1271–1275
287. Uchida Y, Matsukawa N, Oguri T, Sakurai K, Miura T, Iwagaitso, Naniwa ST, Ojika K (2011) Reversible cerebral vasoconstriction syndrome in a patient with Takayasu's arteritis. *Intern Med* 50(15):1611–1614
288. Ducros A (2005) Thunderclap headache. *Rev Neurol* 161:713–715

doi:10.1186/1129-2377-15-49

Cite this article as: Devenney *et al.*: A systematic review of causes of sudden and severe headache (Thunderclap Headache): should lists be evidence based? *The Journal of Headache and Pain* 2014 15:49.

Submit your manuscript to a SpringerOpen[®] journal and benefit from:

- ▶ Convenient online submission
- ▶ Rigorous peer review
- ▶ Immediate publication on acceptance
- ▶ Open access: articles freely available online
- ▶ High visibility within the field
- ▶ Retaining the copyright to your article

Submit your next manuscript at ▶ springeropen.com
