

CLINICAL NOTE

Sudden headache, lumbar puncture, and the diagnosis of subarachnoid hemorrhage in patients with a normal computed tomography scans

Joaquín Valle Alonso¹, Francisco Javier Fonseca del Pozo², Manuel Vaquero Álvarez³, Juan José De la Fuente Carillo⁴, José Carlos Llamas⁴, Yelda Hernández Montes⁴

Objective. To assess the usefulness of computed tomography (CT) to identify subarachnoid bleeding in patients with neurologic deficits seeking emergency care for sudden headache within 6 hours of onset of symptoms.

Methods. Retrospective observational study of patients presenting with sudden nontraumatic headache peaking during the previous hour in the absence of neurologic deficits. We ordered CT scans for all patients, and if the scan was normal we performed a lumbar puncture. All patients were then followed for 6 months.

Results. Eighty-five patients were included. Subarachnoid bleeding was identified in 10 (10.2%) patients by CT. Seventy-four lumbar punctures were performed in patients with negative CTs; the lumbar puncture was positive in 1 patient and inconclusive in 2 patients. In all 3 patients, bleeding was ruled out with later images; thus, no cases of subarachnoid hemorrhage were confirmed in the 74 patients who underwent lumbar puncture. Nor were any cases found in any of these patients during follow-up.

Conclusions. A CT scan taken within 6 hours of onset of sudden headache is sufficient for confirming or ruling out subarachnoid bleeding in patients with sudden headache who have no neurologic deficits.

Keywords: Computed tomography. Lumbar puncture. Subarachnoid hemorrhage. Emergency health services.

Cefalea súbita, punción lumbar y diagnóstico de hemorragia subaracnoidea en pacientes con una tomografía computarizada normal

Objetivo. Valorar la utilidad de la tomografía computarizada (TC) para identificar la hemorragia subaracnoidea (HSA) en pacientes que consultan en el servicio de urgencias por cefalea súbita sin déficit neurológico dentro de las seis primeras horas desde el comienzo de los síntomas.

Método. Estudio observacional, retrospectivo, de pacientes que consultaron por cefalea súbita, no traumática, con un pico de máxima intensidad dentro de la hora previa y sin déficit neurológico. A todos los pacientes se les realizó una TC seguida de una punción lumbar (PL) si la TC era normal, y seguimiento a los 6 meses.

Resultados. Se incluyeron 85 pacientes. Se diagnosticaron 10 (10,2%) casos de HSA en la TC, y se realizaron 74 PL, en pacientes con una TC negativa, de las que una fue positiva y dos no concluyentes, pero en estudios posteriores de imagen se descartó la HSA. En total, la PL en 74 pacientes con TC normal no confirmó ningún caso de HSA. Tampoco se confirmó ningún caso durante el seguimiento.

Conclusiones. En los pacientes con cefalea súbita y sospecha de HSA, sin inconsciencia ni focalidad neurológica, una TC de alta resolución realizada en las primeras 6 horas desde la aparición de la cefalea fue suficiente para confirmar o descartar ese diagnóstico.

Palabras clave: Tomografía computarizada. Punción lumbar. Hemorragia subaracnoidea. Servicio de urgencias.

Introduction

Headache accounts for 2% of consultations to emergency services (EMS). Within this group, sudden onset headache, with an estimated incidence of 43 per 100,000 adults per year in developed countries¹, is the most disturbing, since subarachnoid haemorrhage (SAH) is the cause of between 4% and 12% of cases within this subgroup of patients². The usual approach to rule out a SAH in the EMS is to perform a cranial computed tomography (CT) initially, and if this is nega-

tive, a lumbar puncture (LP) is performed. This is because the sensitivity of CT to rule out an SAH is not 100% and its percentage decreases with the time of evolution of the clinical picture.

In recent years, studies³⁻⁵ have been published that analyse the sensitivity to CT, performed in the first 6 hours, to patients with sudden headache and without neurological focus, to rule out SAH. In a recent meta-analysis⁶ in patients who visited the emergency department with sudden headache and a normal neurological examination, a normal CT scan at 6 hours was extremely

Authors affiliation:

¹Servicio de Urgencias, Royal Bournemouth Hospital, Bournemouth, United Kingdom.
²Instituto Maimónides de Investigación Biomédica/Hospital Reina Sofía/Universidad de Córdoba. DCCU de Montoro, Córdoba, Spain.
³Unidad Gestión Clínica Linares. Centro Salud San José, Jaén, Spain.
⁴Servicio de Urgencias, Hospital Valle de los Pedroches, Pozoblanco, Córdoba, Spain.

Contribution of authors:

All authors have confirmed their authorship in the author's responsibilities documents publication agreement and assignment of rights to EMERGENCIAS.

Corresponding author:

Joaquín Valle Alonso
 Servicio de Urgencias
 Royal Bournemouth Hospital
 Castle Lane 208, Bournemouth
 United Kingdom.

E-mail:

joa51274@hotmail.com

Article information:

Received: 17-10-2016
 Accepted: 19-3-2017
 Online: 30-11-2017

Editor in charge:

Fernando Rosell Ortiz, MD, PhD.

sensitive to rule out SAH. Currently, the sensitivity of CT performed in patients without neurological focus, at 6 hours after the onset of headache approaches 100%. This would avoid performing PL, which is not exempt from complications⁷, which can occur in up to 15% of patients^{5,8}. In our study, the usefulness of CT to identify SAH in patients consulted in the EMS for sudden headache was analysed within the first six hours after the onset of symptoms.

Method

Retrospective observational study of patients who visited EMS for sudden headache (defined as acute non-traumatic headache that reaches its peak of intensity at the time of onset of symptoms), without unconsciousness or neurological focus. The patients underwent a CT, followed by a PL if the CT was normal, as part of the study protocol of sudden headache. An interval of 6 hours was chosen for the CT scan of the skull. The study was conducted in a regional hospital, with an average of 100 daily emergencies, during the period from March 2012 to March 2013. Patients with traumatic SAH, pregnant women and patients under 18 years of age were excluded. The CT used was of the multislice type (4-320 cuts/rotation) with cuts of 5-7.5 mm for the brain and 2.5-5 mm for the posterior fossa. The report of the CT was made by adjuncts of the radiology service, all of them with more than 5 years of experience, and in doubtful cases, the neuroradiologist of the reference hospital was consulted.

Radiologically, SAH was defined as the presence of blood in the subarachnoid space or the identification of an aneurysm in cerebral arteriography. PL was performed in patients with a negative CT and suspicion of SAH. For the subgroup of patients with a negative CT, a follow-up of 6 months was carried out through the digital health history (Diraya program) or telephone calls, by the study investigators, in those patients in whom there were no conclusive data in digital history. Sociodemographic variables were collected, the time of onset of symptoms, the location of the headache, the existence of precipitating factors, the intensity of pain and clinical signs. In the statistical analysis, quantitative variables are expressed as mean and standard deviation or as median and percentiles 25 and 75 (interquartile range) and qualitative variables as proportions. A descriptive statistic was performed using the Fisher exact test with a confidence level of 95% and the Mann-Whitney t test using the SPSS version 20 program. The values of $p < 0.05$ were considered statistically significant.

Results

During the study period, 101 patients were evaluated, of which 4 were excluded (2 for visiting with more than 6 hours of evolution and 2 for loss of follow-up). In 12 patients the CT was diagnostic and ruled out an SAH [(subdural hematoma ($n = 1$), intracranial tumour

($n = 3$), intracranial haemorrhage ($n = 3$), venous thrombosis ($n = 2$) and cerebral infarction ($n = 3$)] so that PL was not performed, and were excluded from the analysed group, for the final analysis, 85 patients were included.

The median age of the patients was 41.2 years [interquartile range 18-84], 38.8% of the patients were men. Through CT, 11 positive cases of HSA were detected. In one of these patients, the results of the angiography and the re-examination of the CT images confirmed a normal result. The incidence of SAH was 12.1%. In total, 74 PLs were performed, one was positive, two were inconclusive and the rest were negative. In the case of patients with positive PL and the two inconclusive patients, HSA was discarded after carrying out further imaging studies with cerebral angioCT. All the patients with a negative CT and a negative PL, positive or inconclusive, as well as the patient with the false positive CT were followed up at 6 months. There were no adverse events during the 6 months of follow-up.

Table 1 shows the characteristics of the study patients, according to whether or not they presented HSA. In the case of patients with SAH, it was more frequent to go to the EMS by ambulance ($p = 0.010$) and the occipital location of the headache ($p = 0.012$). Clinical signs included the presence of syncope ($p = 0.036$), neck pain or stiffness ($p = 0.010$), photophobia ($p = 0.001$), nausea or vomiting ($p = 0.000$), as well as higher systolic blood pressure figures (mean 153 vs 126) and diastolic (mean of 100 vs 80) ($p = 0.000$).

Table 2 shows the final diagnoses; the most frequent (38.8%) was the diagnosis of migraine headache. 9.4% of patients presented a diagnosis of severe prognosis, such as meningitis and reversible cerebral vasoconstriction syndrome, with 4.7% of cases in both pathologies.

Discussion

Headache is an important cause of consultation in the EMS. Sudden headache, and within this group, SAH is the most important aetiology to differentiate. Patients with SAH may be relatively young, with little or no comorbidity, but with a high probability of adverse sequelae. The estimated incidence of sudden headache is around 43 per 100,000 adults per year in the developed world according to Landtblom¹¹, using as a definition a headache that reaches a maximum intensity at 60 seconds from the beginning. In our study, the annual incidence was 143 per 100,000 adults. A much higher incidence, although it was considered sudden headache when the pain reached its intensity peak within the hour of the onset of symptoms and not only at 60 seconds. This criterion was used because it is used in recent studies that assess the sensitivity of CT in HSA³⁻⁵. In any case, the incidence found, 12 cases/100,000 inhabitants/year, is greater than the one reported in Europe and Spain of 9 cases/100,000 inhabitants-year⁹. One possible explanation would be that in our health area, the popula-

Table 1. Univariate analysis of the epidemiological and clinical characteristics of the patients included in the study according to the final diagnosis of subarachnoid haemorrhage

	Total N = 85 n (%)	HSA N = 10 n (%)	No HSA N = 75 n (%)	P value
Mean age	41.2 (SD 17.7)	53.0 (SD 19.3)	39.6 (SD 17.0)	0.024
Sex				0.792
Women	52 (61.2)	7 (13.5)	45 (86.5)	
Men	33 (38.8)	3 (9.1)	30 (90.9)	
Go to the emergency service by ambulance	35 (41.2)	8 (22.9)	27 (77.1)	0.010
History of headache				
Migraine background	20 (23.5)	2 (10.0)	18 (90.0)	0.924
Possible migraine diagnosis	9 (10.6)	1 (11.1)	8 (88.9)	0.766
Tension headache	4 (4.7)	0 (0.0)	4 (100.0)	0.984
Another type of headache*	5 (5.9)	0 (0.0)	5 (100.0)	0.866
Location of headache				
Occipital	20 (23.5)	6 (30.0)	14 (70.0)	0.012
Temporal	10 (11.8)	1 (10.0)	9 (90.0)	0.753
Parietal	7 (8.2)	0 (0.0)	7 (100.0)	0.611
Frontal	18 (21.2)	1 (5.6)	17 (94.4)	0.610
Global	20 (23.5)	2 (10.0)	18 (90.0)	0.907
Ocular	10 (11.8)	0 (0.0)	10 (100.0)	0.836
Precipitating factors				
Any	47 (55.3)	5 (10.6)	42 (89.4)	0.984
Sexual activity	7 (8.2)	2 (28.6)	5 (71.4)	0.407
Physical exercise	12 (14.1)	2 (16.7)	10 (83.3)	0.932
Valsalva	2 (2.3)	0 (0.0)	2 (100.0)	0.788
Emotion	4 (4.7)	0 (0.0)	4 (100.0)	0.899
Cough	3 (3.5)	1 (33.3)	2 (66.7)	0.788
Intensity				
Time to maximum pain intensity (min)	2.20 (SD 1.3)	1.5 (SD .97)	2.25 (SD 1.4)	0.081
Worst headache of life	63 (74.1)	9 (14.3)	54 (85.7)	0.207
Clinical signs and symptoms				
Fever	3 (3.5)	1 (33.3)	2 (66.7)	0.788
Syncope	3 (14.1)	2 (66.7)	1 (33.3)	0.036
Neck pain or stiffness	9 (10.6)	4 (44.4)	5 (55.6)	0.010
Nausea vomiting	21 (24.7)	8 (38.1)	13 (61.9)	< 0.001
Photophobia	14 (16.5)	6 (42.9)	8 (57.1)	0.001
Medium systolic bp	129 (DT 22)	153 (DT 18)	126 (DT 20)	< 0.001
Mean diastolic bp	83 (DT 13)	100 (DT 13)	80 (DT 12)	< 0.001

SD: standard deviation; SAH: subarachnoid haemorrhage; bp: blood pressure.

*Another type of headache includes cluster headache, paroxysmal episodic hemicrania, headache due to abuse of non-steroidal anti-inflammatory drugs and headache due to opioid abuse.

tion over 65 years old exceeds 24% and an increase in the incidence of SAH has been observed after 50 years¹⁰.

The most important finding was that, in case of suspicion of SAH, the CT performed within the first 6 hours from the onset of symptoms, allowed 100% diagnosis of patients, so it seems safe to avoid a PL if the CT is normal in the first 6 hours. Some studies have presented less convincing results, indicating a CT sensitivity of 95% to 97%. Most of these studies include few patients, and patients were not stratified according to the time from the onset of symptoms to the completion of CT. It is well known that the sensitivity of CT decreases with the time elapsed since the onset of symptoms, in addition, some of these studies included older CT equipment¹¹⁻¹⁵.

A recent systematic review⁶ on the sensitivity of CT to exclude SAH at 6 hours after the onset of symptoms included 5 studies^{3-5,16-18} with a total of 8,907 patients. This study concludes that in patients presenting in the emergency department with sudden headache and normal neurological examination, nega-

tive CT within 6 hours of the onset of headache is extremely sensitive to rule out SAH secondary to an aneurysm.

Although in general the PL is considered safe, it is not free of complications. In our study, 7 (7.2%) patients experienced post-puncture headache, returning to the EMS, and it was necessary to admit 2 of them for pain control. In the case of patients with sudden headache and suspected infection, the importance of performing PL is highlighted.

The limitations of the study were not to include cases of SAH with a score on the Glasgow scale of less than 8 or with signs of neurological focality, which excludes possible HSAs that study these data. The study is based on the experience of a centre, which limits its reproducibility in other scenarios. The number of patients included is relatively small, so perhaps it is not enough to conclude that a negative CT within the first 6 hours of evolution in a patient with a sudden onset headache does not require a PL, although our results are chords to the most recent literature.

We can conclude that in patients with sudden hea-

Table 2. Final diagnoses after follow-up at 6 months

Diagnosis	Frequency n (%)
Reversible vasoconstriction syndrome	4 (4.7)
HaNDL syndrome	1 (1.2)
Meningitis	4 (4.7)
Migraine with aura	14 (16.5)
Migraine without aura	19 (22.3)
Tension headache	11 (12.9)
Primary thunderhead thunder	2 (2.3)
Cluster headache	3 (3.5)
Paroxysmal hemicrania	2 (2.3)
SUNCT	1 (1.2)
Others	14 (16.5)

HaNDL: transient headache syndrome and neurological deficits with lymphocytosis in the cerebrospinal fluid (syndrome of transient Headache and Neurological Deficits with cerebrospinal fluid Lymphocytosis); SUNCT: Short-lasting unilateral neuralgiform headache with conjunctival injection and tearing; other non-neurological diagnoses (pneumonia, sinusitis, otitis media, sinusitis, somatization and conversion disorder, headache due to abuse of analgesics, cocaine overdose, temporal arteritis, ischemic heart disease, headache due to opioid abuse, non-specific headache).

dache and clinical suspicion of SAH, without unconsciousness or neurological focus, high-resolution CT, performed in the first 6 hours of evolution and interpreted by an experienced radiologist, may be sufficient to rule out this diagnosis

Conflicting interests

The authors declare no conflict of interest in relation to this article.

Financing

The authors declare the non-existence of external financing of this article.

Ethical Responsibilities

All authors have confirmed the maintenance of confidentiality and respect for patients' rights in the author's responsibilities document, publication agreement and assignment of rights to EMERGENCIAS.

Article not commissioned by the Editorial Committee and with external peer review

References

- Ducros A, Bousser MG. Thunderclap headache. *BMJ*. 2013;346:e8557.
- Edlow JA, Caplan LR. Avoiding pitfalls in the diagnosis of subarachnoid hemorrhage. *N Engl J Med*. 2000;342:29-36.
- Perry JJ, Stiell IG, Sivilotti ML, Bullard MJ, Emond M, Symington C, et al. Sensitivity of computed tomography performed within six hours of onset of headache for diagnosis of subarachnoid haemorrhage: Prospective Cohort Study. *BMJ*. 2011;343:d4277.
- Backes D, Rinkel GJ, Kemperman H, Linn FH, Vergouwen MD. Time-dependent test characteristics of head computed tomography in patients suspected of nontraumatic subarachnoid hemorrhage. *Stroke*. 2012;43:2115-9.
- Blok KM. CT within 6 hours of headache onset to rule out subarachnoid hemorrhage in nonacademic hospitals. *Neurology*. 2015;84:1927-32.
- Dubosh NM, Bellolio MF, Rabinstein AA, Edlow JA. Sensitivity of early brain computed tomography to exclude aneurysmal subarachnoid hemorrhage: A Systematic Review and Meta-Analysis. *Stroke*. 2016;47:750-5.
- Evans RW. Complications of lumbar puncture. *Neurol Clin*. 1998;16:83-105.
- Shah KH, Richard KM, Nicholas S, Edlow JA. Incidence of traumatic lumbar puncture. *Acad Emerg Med*. 2003;10:151-4.
- Heuschmann PU, Di Carlo A, Bejot Y, Rastenyte D, Ryglewicz D, Sarti C, et al, European Registers of Stroke (EROS) Investigators. Incidence of stroke in Europe at the beginning of the 21st century. *Stroke*. 2009;40:1557-63.
- Lagares A, de Toledo P, Fernández-Alén JA, Ibáñez J, Arkan F, Sarabia R, et al, Por el Grupo de Trabajo de Patología Vasculard de la Sociedad Española de Neurocirugía (SENEC). Base de datos multicéntrica de hemorragia subaracnoidea espontánea: presentación, criterios de inclusión y desarrollo de una base de datos en internet. *Neurocirugía (Astur)*. 2008;19:405-15.
- Landtblom AM, Fridriksson S, Boivie J, Hillman J, Johansson G, Johansson I. Sudden onset headache: a prospective study of features, incidence and causes. *Cephalgia*. 2002;22:354-60.
- Morgenstern LB, Luna-Gonzales H, Huber JC Jr, Wong SS, Uthman MO, Gurian JH, et al. Worst headache and subarachnoid hemorrhage: prospective, modern computed tomography and spinal fluid analysis. *Ann Emerg Med*. 1998;32:297-304.
- Van der Wee N, Rinkel GJ, Hasan D, van Gijn J. Detection of subarachnoid haemorrhage on early CT: is lumbar puncture still needed after a negative scan? *J Neurol Neurosurg Psychiatry*. 1995;58:357-9.
- O'Neill J, McLaggan S, Gibson R. Acute headache and subarachnoid haemorrhage: a retrospective review of CT and lumbar puncture findings. *Scott Med J*. 2005;50:151-3.
- Sidman R, Connolly E, Lemke T. Subarachnoid hemorrhage diagnosis: lumbar puncture is still needed when the computed tomography scan is normal. *Acad Emerg Med*. 1996;3:827-31.
- Sames TA, Storrow AB, Finkelstein JA, Magoon MR. Sensitivity of new-generation computed tomography in subarachnoid hemorrhage. *Acad Emerg Med*. 1996;3:16.
- Stewart H, Reuben A, McDonald J. LP or not LP, that is the question: gold standard or unnecessary procedure in subarachnoid haemorrhage? *Emerg Med J*. 2014;31:720-3.
- Mark DG, Hung YY, Offerman SR, Rauchwerger AS, Reed ME, Chettipally U, et al. Nontraumatic subarachnoid hemorrhage in the setting of negative cranial computed tomography results: external validation of a clinical and imaging prediction rule. *Ann Emerg Med*. 2013;62:1.e11-10.e1.