Diagnostics in patients presenting to the emergency room with headache

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Chapter 2

THE VALUE OF CT ANGIOGRAPHY IN PATIENTS WITH ACUTE SEVERE HEADACHE

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ABSTRACT

Background

Patients with acute severe headache may have a secondary form of headache. Standard head computer tomography (CT) and cerebrospinal fluid (CSF) examination are often performed in absence of neurological deficits to exclude subarachnoid hemorrhage (SAH). Increasingly patients undergo subsequent CT angiography (CTA) to exclude cerebral venous thrombosis (CVT), dissection or reversible cerebral vasoconstriction syndrome (RCVS). It is unknown whether this additional imaging increases diagnostic yield. We aimed to evaluate the yield of CTA in patients with acute severe headache with normal neurological examination and no abnormalities at standard CT and CSF analysis.

Methods

We included consecutive patients presenting to the emergency room between January 2008 and May 2011 with acute severe headache and without abnormalities at neurological examination, CT and CSF research, who received a CTA in the diagnostic process in our teaching hospital. All scans were re-reviewed by an experienced neuroradiologist.

Results

We included 70 patients, 71% were women and average age was 45 years. We found a vascular abnormality in 13 (19%) of our patients. Four had either a prior aneurysm or CVT. Eight patients had an unruptured intracranial aneurysm (UIA) on CTA (11%), 2 had CVT (3%), 2 had RCVS (3%) and 1 had cerebral ischemia (1%).

Conclusions

We found a high percentage of vascular abnormalities. A third of these patients had a prior episode of either an aneurysm or CVT. In patients with a history of UIA or CVT performing CTA despite normal CT and LP therefore seems warranted. A prospective study to delineate indications for CTA is needed.

BACKGROUND

Acute severe headache is defined as a headache of extreme severity that reaches its maximum within minutes and lasts for >1 hour. Acute severe headache may be a presenting symptom of, among others, a subarachnoid hemorrhage (SAH), cerebral venous thrombosis (CVT), arterial dissection, cerebral ischemia or reversible cerebral vasoconstriction syndrome (RCVS). Many studies have been published with regard to the correct sequence and content of diagnostic procedures. When standard CT is performed within six hours of the start of the headache SAH can be excluded, if performed in a center specialized in SAH. If CT is performed later, or if headache is atypical a lumbar puncture (LP) is still indicated [1,2]. However, in following this approach several diagnoses with severe consequences, other than SAH, may be missed. For example CVT may present with acute severe headache, without neurological deficit in 3-13% of cases [3,4]. Cervical arterial dissection has been reported to present with acute headache as the only symptom in 20% of cases [5,6]. Also, unruptured aneurysms are being reported as a possible cause of acute headache in several case reports [7-9]. RCVS has been reported to present with isolated headache in 57% to 88% of the cases [10].

CTA is increasingly used in patients with acute severe headache to rule out vascular abnormalities and has been proven valuable in detecting aneurysms [11]. To our knowledge there are no prospective studies investigating the gain of CTA in patients with acute severe headache, normal neurological exam and normal standard CT. One retrospective study that reviewed CTA in this group, found a higher percentage of vascular abnormalities (6.6%) than expected in the general population. However, lumbar punctures were not performed in that cohort. Also their study population was entirely Asian making extrapolation to our population difficult [12].

The risks of performing standard CTA include nephrotoxicity, added radiation exposure and allergic reactions. Furthermore, diagnostic procedures such as CTA increase costs. It is unclear whether these negative effects outweigh possible prevention of morbidity with a more aggressive screening approach. A study focusing on the added yield of CTA in patients with acute headache showed that CTA may be used selectively based on standard CT findings, thus increasing specificity and reducing patient risk [13]. We investigated the yield of CTA in patients with acute severe headache, without neurological deficit and a normal CT head and CSF for detecting vascular abnormalities.

PATIENTS AND METHODS

We performed a retrospective analysis researching the imaging findings of patients who presented at the emergency room in our large regional teaching hospital. These patients were previously described in a study focusing on cerebrospinal fluid (CSF) diagnostics [14]. For that

study we included patients from January 2008 through May 2011 with acute, non-traumatic, most severe ever, headache who underwent a lumbar puncture. For the present study we excluded patients with neurological deficits on examination, pathological findings on standard head CT, such as SAH or subdural hematoma, and patients with an increased bilirubin concentration (>0.2 µmol/l) in CSF. All imaging modalities were evaluated by specialized neuroradiologists at the time of presentation. The conclusions of the scans that were made at that time were collected. For this study all scans of included patients were re-reviewed by an experienced neuroradiologist. In accordance to hospital protocol CSF research was performed at least 12 hours after the onset of symptoms in all patients with normal standard CT. Collected samples were transported to the in-house laboratory and protected continuously from light. We documented and evaluated the outcome of performed CTA's. The CTA depicts both the arterial and venous system of intra- and extracranial vessels, by scanning the early and late phase of contrast passage. All patients underwent scanning by GE Lightspeed 64 slice CT scanner. Where available we also evaluated MRI and MRA data. Patient data were processed and descriptive statistics were done using SPSS 20.

RESULTS

Between January 2008 and May 2011, 361 patients presenting with acute and worst ever headache were seen in the emergency department. We included 70 patients who received a CTA and had normal neurological exam, normal CSF bilirubin and normal non-contrast CT's (see figure 1 for patient flow). All but one scan were made within a week of the occurrence of the headache; one scan was made after three weeks. All patients received CTA imaging of the head and the intra- and extracranial vessels down to the level of the fourth cervical vertebra and 31 patients were additionally scanned down to the aortic arch. Of our patients 50% received sufficient imaging of the cervical arteries to exclude dissection, including subsequent MRA.

The average age in this group was 45 years, ranging from 17 to 80 years old and 50 were women (71%). Nine patients had a prior history of migraines, eight had a history of tension type headache and the other 53 patients had no history of prior headaches. Of our patients 61 presented with generalized headache, in 19 there was unilateral headache. Nausea and vomiting were present in respectively 30 and 16 patients. Thirteen (19%) had a vascular abnormality, which had clinical consequences for ten patients (table 1). Eight had an aneurysm (11%, 95% CI: 4% to 19%). In three patients the aneurysm was coiled, in another three clipped and two patients received follow up CTA's to monitor aneurysm size. Four patients had small aneurysms of 2 and 3 mm and four patients had larger aneurysms ranging from 7.5 to 12mm. Three patients had been treated on a previous occasion after an SAH, but now had a second episode of acute headache and a de novo aneurysm. These aneurysms had not been seen on previous imaging. During our current revision they were not visible on previous scans either and were truly deemed de novo aneurysms. Of these de novo aneurysms one was also clipped and two were coiled. All three

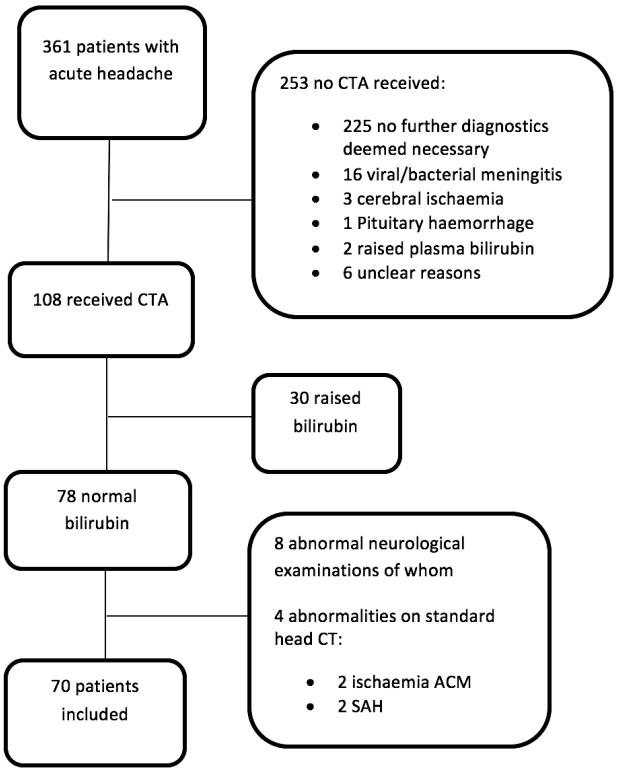

Figure 1. Patient inclusion flowchart

patients were included after the second headache episode. We found 2 patients with a CVT (3%) One patient with CVT had her diagnosis confirmed on MRA, as CTA findings were suspect. The other had a prior CVT and returned with a new episode of acute severe headache, nausea and vomiting. The CVT had progressed when compared to prior imaging. There were no other patients with a prior history of SAH or CVT, one patient had a prior, treated, AVM but now had normal CT, LP and CTA.

One patient had ischemia of the posterior circulation in the right occipital area. This patient presented with acute headache and non vertiginous dizziness. Ischemia was visible as this scan was performed two days later and had become demarcated.

Two patients had RCVS and were not diagnosed at initial presentation, but after reviewing the CTA's for this study. These were the only new abnormalities found by re-reviewing the scans. One patient presented with a single headache episode. The other visited again with another headache episode two days later, but remained undiagnosed at that time. Both did not revisit the emergency room or outpatient clinic after these episodes.

Table 1. Radiological findings and follow up in patients with pathology on CTA

Patient	Age	Sex	CT-A	Neurological history	Time to LP from headache onset	Follow up
	31	F	Right MCA aneurysm 2 mm	Right carotid top aneurysm	20 hours	Clipped
2	67	F	ACA aneurysm 3 mm		29 hours	CT follow up
3	62	M	MCA aneurysm 3 mm		Days, not specified	Clipped
4	54	F	Left MCA aneurysm 8 mm		Days, not specified	Coiled
5	61	F	A. com aneurysm 7.5 mm		One week	Coiled
6	58	F	P. com aneurysm 2 mm		36 hours	CT follow up
7	38	F	ICA aneurysm 7.5 mm	P. com aneurysm	1 day	Coiled
8	48	F	PCOM aneurysm 12 mm	A. opthalmica aneurysm	5 days	Coiled
9	37	M	CVT (2011)	CVT (2010)	Two weeks	Anticoagulant therapy
10	53	F	Cortical CVT	Ischemia left ACM territory	Three days	None
11	48	M	RCVS		Three weeks	None
12	30	F	RCVS		1 day	One episode of recurrent headache
13	73	M	Ischemia posterior circulation, right occipital area		1 day	Stroke follow up

Legend: ACA: anterior cerebral artery, MCA: middle cerebral artery, P. com Posterior communicating artery, A. com anterior communicating artery, ICA interior carotid artery, CVT cerebral venous thrombosis, RCVS reversible cerebral vasoconstriction syndrome

Of all 70 patients 15 patients underwent an additional MRI, four of whom had an aneurysm diagnosed with CTA and one of whom had CVT confirmed. In the remaining 10 patients who received MRI no pathology was found.

DISCUSSION

In this study we set out to evaluate the diagnostic yield of CTA in headache patients with a normal neurological examination, normal standard CT and normal lumbar puncture. With CTA we found a surprisingly high percentage of underlying vascular abnormalities (19%). Three patients had a prior SAH and one prior CVT. These findings had clinical consequences for ten patients.

In the general population the prevalence of aneurysms is estimated to be around 3.2% [15,16]. However, after correction for age and the percentage of women, the prevalence in our group should is calculated to be 3.6% [16]. Possibly this percentage is an underestimation as we have no data on family prevalence in our group and some patients had prior aneurysms. According to this prevalence we would have expected to find at least 3 aneurysms in our group of 70 patients. We found eight aneurysms (11%), with a 95% confidence interval from 4% to 19%. Half of the found aneurysms were small, but the other half were larger: up to 12mm. Whether the finding of an aneurysm caused the acute headache in our patients is debatable as lumbar punctures were normal. Nevertheless it has been suggested that unruptured aneurysms may cause headache due to inflammation or sudden distension. Three patients had a de novo aneurysm after treatment for prior aneurysmatic SAH. Two patients had CVT, one of whom had a prior CVT which had now progressed. Our study suggests that patients with prior SAH, and possibly CVT, should receive CTA despite normal CSF after a second episode of acute headache. In our group 5 patients had a prior history of cerebral vascular abnormalities. The four patients mentioned above and a patient with a history of a treated AVM who now had a normal CTA. This would mean 80% of the patients in our group of 70 with a history of cerebral vascular disease and a recurrent thunderclap headache had a de novo cerebral abnormality.

We found two patients with RCVS. This may be explained as cortical subarachnoid hemorrhage can be found in these patients, and the presence of abnormalities on standard head CT was an exclusion criterion in our study. Also RCVS may be more accurately diagnosed by repeated neuro-imaging and possibly MRA [17]. We found no dissections, which may be due to the fact that only 50% of patients received sufficient imaging of the carotid and vertebral arteries to exclude this diagnosis.

Our study has several limitations. First due to the retrospective design of our study there may be an indication bias. The patients with prior aneurysms and CVT are logical candidates for follow up by CTA, possibly increasing the chance of finding vascular abnormalities. Second this study is single center so our findings may not be generalizable. Tertiary headache centers may

find higher yield by referral bias, whereas primary centers may find lower percentages. The assessment of all clinical symptoms, such as detailed headache characteristics, was beyond the scope of this study.

One study with a similar design found 6.6% vascular lesions in 512 patients (33 aneurysms, 2 Moya Moya syndromes and 1 dissection), also suggesting value in performing CTA in this patient group [12]. The lower percentage of vascular abnormalities in that group compared to our findings may be partially explained by their exclusion of patients with prior intracranial vascular pathology. If these patients are excluded from our data, we still find 9 (14%) patients with vascular abnormalities. An important discrepancy with our methods is that lumbar punctures were not performed in this group to exclude hemorrhage, moreover, all their patients were Asian limiting the extrapolation of that study to our population.

Evidence from earlier studies suggests that patients with acute severe headache, without pathological findings on non-contrast CT and lumbar puncture do not require follow up, however, some if these studies did not perform CTA and focused mainly on SAH [18-22].

A prospective study performing CTA in patients with acute headache, normal neurological examination, normal head CT and normal lumbar puncture is needed, to investigate the yield of CTA and assess whether it is possible to make a selection for CTA for specific subgroups of patients based on clinical characteristics, thus reducing unnecessary exposure to radiation and intravenous contrast.

ETHICAL STANDARDS

As this was a retrospective study, without medical interventions, patient consent was not required according to hospital protocol and national guidelines.

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