

The role of lumbar puncture in the diagnosis of subarachnoid hemorrhage when computed tomography is unavailable

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ABSTRACT

Subarachnoid hemorrhage (SAH) is an important but uncommon condition in the differential diagnosis of acute headache. Most authorities recommend that patients with suspected SAH undergo noncontrast computed tomography (CT) as a first diagnostic intervention. If the results of the CT scan are negative, a lumbar puncture should be performed. Many nonurban Canadian hospitals do not have CT scanners and must either transfer patients or consider performing lumbar puncture prior to CT. In selected patients, performing lumbar puncture first may be an option, but timing of the procedure and the interpretation of results is important.

Key words: Subarachnoid hemorrhage, lumbar puncture, computed tomography, rural emergency

RÉSUMÉ

L'hémorragie sous-arachnoïdienne (HSA) est une atteinte importante mais rarement rencontrée lors du diagnostic différentiel de la céphalée aiguë. La plupart des experts dans le domaine recommandent comme première intervention diagnostique de faire subir un tomodensitogramme (sans substance de contraste) aux patients chez qui l'on soupçonne une HSA. Si les résultats du tomodensitogramme sont négatifs, on devrait procéder à une ponction lombaire. De nombreux hôpitaux canadiens non urbains ne possèdent pas de tomodensitomètre et doivent soit transférer les patients ou songer à effectuer une ponction lombaire avant la tomodensitométrie. Chez des patients sélectionnés, la ponction lombaire en premier pourrait être une option, mais le moment choisi pour procéder à l'intervention et l'interprétation des résultats sont importants.

Introduction

Headache is a common emergency department (ED) presenting complaint, and the differential diagnosis is extensive. Serious pathology is present only in 1% of all headache sufferers and in 15% of those with abnormal history or physical examination.¹ The most concerning signs and symptoms are severe headache, sudden onset, fever, neck stiffness and “worst ever” pain. Emergency physicians must be able to reliably identify patients who present

with serious conditions, especially acute vascular or infectious events.

Subarachnoid hemorrhage (SAH) is a difficult diagnostic challenge, and only 10%–25% of patients with classic presentations of sudden severe headache have documented SAH.^{1–3} Most authorities^{1,4–6} recommend that patients with suspected SAH undergo noncontrast computed tomography (CT) as a first diagnostic intervention. If the results of the CT scan are negative, a lumbar puncture (LP) should be performed. Unfortunately, CT is unavailable in most

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nonurban (population <15 000) Canadian settings and bed availability at referral centres is increasingly limited, making timely transfer of seriously ill patients a difficult problem for rural physicians.

In most settings, performing an LP is feasible and has been proposed as an initial investigation for some patients — notably those with lone acute sudden headache (LASH) who have a normal neurological exam, no neck stiffness and no fever.^{2,6,7} LP provides definitive diagnostic information in many cases, enabling better decisions about the need for and urgency of transfer. The following case studies illustrate the dilemma facing physicians whose only investigational tool is the LP.

Case 1

A 68-year-old previously healthy woman presented to the ED at 2200 with severe generalized headache, her worst ever (rated 10/10). The headache had come on abruptly over 1 to 2 minutes, and she had vomited several times in the 2 hours since. She had no history of prior headaches and reported no trauma.

On examination she looked unwell and was curled up on her side holding her head. Her pulse was 68 beats/min, blood pressure 177/78 mm Hg, respiratory rate 28 breaths/min, temperature 36.1°C, oxygen saturation 98%, and Glasgow Coma Scale (GCS) score of 15. She had slight meningismus but negative Kernig's and Brudzinski's signs. Detailed neurological examination demonstrated no other abnormal findings, and her complete blood count (CBC) was normal.

Anti-emetics and analgesics given in the ED relieved her nausea but not her headache. Because CT was not available, the patient consented to an LP, which was completed approximately 4 hours after headache onset. Results of the LP showed only an elevated protein level (Table 1), but because intracranial pathology was suspected, a neurosurgeon was consulted. The patient appeared stable, so arrangements were made to transfer her by helicopter at daybreak — 6 hours later. She was observed closely in the ED pending transfer.

Table 1. Results of lumbar puncture for Case 1

Blood	1–3 RBCs/mm ³
WBC count	0
Protein	1.03 g/L (normal, 0.15–0.45 g/L)
Glucose	3.1 mmol/L
Xanthochromia	None visualized
Micro	No bacteria

RBC = red blood cells; WBC = white blood cells

Three hours later, the ED physician was called back because of declining neurological function. Re-examination showed normal vitals signs but increasing lethargy, a GCS score of 12 and minor right-sided weakness. The patient was intubated and transferred to the tertiary centre within 60 minutes. A CT scan revealed an intracerebral hematoma in the left occipital region, which was subsequently evacuated. The patient recovered with residual right hemianopsia and dysphasia.

Case 2

A previously healthy 19-year-old woman presented at 0900 with nausea, vomiting, abdominal cramps, diarrhea, headache and photophobia, which had developed over several hours. Past history was remarkable for episodes of moderate headache lasting several days during the preceding year. Her temperature was 35.5°C, pulse 60 beats/min, blood pressure 98/62 mm Hg, respiratory rate 16 breaths/min, and she had a GCS score of 15. She had slight meningismus and minor abdominal guarding, but the physical examination was otherwise unremarkable. Her CBC was normal, and a provisional diagnosis of viral enteropathy was made.

Over a 6-hour period, she was treated with intravenous fluids and antiemetics. Her gastrointestinal symptoms resolved, but her headache and photophobia remained moderately severe. Re-examination revealed no focal neurological abnormalities; however, her meningismus persisted to the same or greater degree and the possibility of SAH or meningitis was considered. The patient consented to an LP, which revealed significant subarachnoid blood (Table 2). The patient was transferred out to a neurosurgeon, a berry aneurysm was identified and clipped, and the patient recovered uneventfully.

Discussion

These cases illustrate the difficulties facing physicians who practise without neuro-imaging modalities. Both were atypical presentations of life-threatening pathology and

Table 2. Results of lumbar puncture for Case 2

Blood	1800 RBCs/mm ³
WBC count	40 WBCs/mm ³ (57% neutrophils, 43% lymphocytes)
Protein	2.6 g/L (normal, 0.15–0.45 g/L)
Glucose	3.6 mmol/L
Xanthochromia	Positive visually
Micro	No bacteria

RBC = red blood cells; WBC = white blood cells

both required early transfer for neurosurgical care. With today's pressure on Canadian tertiary hospitals, it is often difficult for nonurban physicians to transfer any patient, let alone those with atypical findings. In cases of possible SAH, the lumbar puncture may provide essential diagnostic information, and if meningitis is a consideration, early LP is mandatory.

In cases of possible SAH, the timing of the LP may be important. Review articles suggest that LP sensitivity reaches 100% only after 12 hours after the onset of symptoms,^{1-3,8} but maintains this high level for up to 14 days.^{1,3} Conversely, CT sensitivity does not peak until 24 hours, then drops to 85% by day 5. Moreover, CT is only 57% sensitive for sentinel bleeds,⁵ which means SAH has not been ruled out until the LP is negative. Given the delays related to presentation, clinical evaluation and management of otherwise stable patients in nonurban settings, and recognizing the likelihood of transfer difficulties, it may be reasonable in patients with more benign presentations to delay the LP until 12 hours after symptom onset^{1,2} or to repeat the LP if the initial tap was negative and clinical suspicion remains high.

LP first?

Both the American College of Emergency Physicians⁴ and the British Society of Neurological Surgeons have included an "LP First" statement in their headache guidelines.^{4,9} They recommend that if CT is not readily available, LP may be considered for patients with normal mentation and no neck stiffness, focal findings or signs of increased intracranial pressure. Prospective studies^{6,7} indicate that about 70% of acute headache presentations would meet these criteria. Schull² proposed that patients with LASH compatible with SAH, who have normal neurological exam, normal level of consciousness and no neck stiffness could undergo LP first, although this protocol has not been clinically tested. The premise of his argument is to save expensive resources (CT scanning) without losing diagnostic sensitivity or risking patient safety. It must be pointed out that, in urban settings, the LP First model would reduce unnecessary CTs, while in nonurban Canada it would reduce unnecessary patient transfers.

LP diagnostic criteria

With respect to SAH, <10 (red blood cells) RBCs/mm³ constitutes a negative tap, while counts over 100/mm³ in all tubes should be considered positive, especially if xanthochromia is present. A marked decline in the RBC count between the first and third tubes suggests a traumatic tap. If the LP has been done within 2 to 4 hours of symptom

onset and a traumatic tap is suspected, the centrifuged supernatant should be clear, since xanthochromia requires several hours to develop. If a traumatic tap is suspected and the time frame makes xanthochromia unreliable, the LP may be repeated at a different spinal level.^{1,10}

Xanthochromia

When blood enters the subarachnoid space, RBCs lyse and hemoglobin is denatured to oxyhemoglobin and bilirubin, giving the characteristic yellow hue of xanthochromia.⁸ Because a traumatic tap releases RBCs into the spinal fluid, xanthochromia is a more specific indicator of SAH than RBCs alone.^{1,5} Any xanthochromia indicates bleeding into the cerebrospinal fluid (CSF), but the degree of xanthochromia depends on the amount of blood released and the duration of CSF exposure. Xanthochromia has been reported as early as 2 to 4 hours post bleed,^{8,10} but SAH can only be ruled out if it is absent 12 hours after symptom onset.^{1-3,8} Xanthochromia can be determined visually or, more sensitively, by spectrophotometry. Visual assessment misses up to 50% of positive samples,¹¹ which is important in smaller hospitals where spectrophotometry is not available, because an early negative LP can be false-negative. Repeating the LP in a few hours could improve the chances of finding RBCs or xanthochromia.

LP risks

Sudden neurological deterioration due to intracranial pressure shift is one of the most frequently cited risks of LP, and this is the reason generally cited for performing a non-invasive test like CT first. However, neurological deterioration following LP has been reported most often^{12,13} in older retrospective studies that included patients with focal neurological findings and higher Hunt-Hess Scale grades.^{9,14} Of note, clinical examination is a more reliable marker of increased intracranial pressure than CT, and with normal mentation and no focal signs, an LP First strategy may be acceptable — especially if CT is not readily available.^{2,4,9}

Conclusion

Sudden or severe headaches pose a diagnostic dilemma for rural physicians who lack access to neuro-imaging modalities. If SAH is a diagnostic consideration, an LP First strategy may be reasonable in selected patients. LP before CT is thought to be safe in patients with LASH who have normal mentation and no neck stiffness, focal findings or other signs of increased intracranial pressure, although this strategy has not been prospectively studied. Physicians should remember that CSF samples taken early after

symptom onset may be false-negative for xanthochromia and, in unclear situations, early negative LPs should be followed by a second tap at the 12-hour mark, when sensitivity approaches 100%.

Competing interests: None declared.

References

1. Edlow JA, Caplan LR. Avoiding pitfalls in the diagnosis of subarachnoid hemorrhage. *N Engl J Med* 2000;342:29-36.
2. Schull MJ. Lumbar Puncture First? An old test and a new approach to lone acute sudden headaches. *CJEM* 1999;1(2):99-102.
3. Evans RW. Diagnostic testing for the evaluation of headaches [review]. *Neurol Clin* 1996;14(1):1-26.
4. Clinical policy on the initial approach to adolescents and adults presenting to the emergency department with a chief complaint of headache. American College of Emergency Physicians. *Ann Emerg Med* 1996;27(6):821-44.
5. Guertler AT. Pearls, pitfalls and updates. The clinical practice of emergency medicine. *Emerg Med Clin N Am* 1997;15:303-5.
6. Linn FH, Wijdicks EF, van der Graaf Y, Weerdesteyn-van Vliet F, Bartel N, Gijn J. Prospective study of sentinel headaches in aneurysmal subarachnoid hemorrhage. *Lancet* 1994;344:590-3.
7. Lledo A, Calandra L, Martinez-Menendez B, Perez-Sempere A. acute headache of recent onset and subarachnoid hemorrhage: a prospective study. *Headache* 1994;34:172-4.
8. Ravel R. *Clinical laboratory medicine*. 6th ed. St. Louis (MO): Mosby-Year Book Inc.; 1995. p. 303.
9. Wasserberg J, Barlow P. Lesson of the week. Lumbar puncture still has an important role in diagnosing subarachnoid haemorrhage. *BMJ* 1997;315:1598-9.
10. Roberts JR. *Clinical procedures in emergency medicine*. 3rd ed. Philadelphia: WB Saunders Co.; 1998. p. 1055-6.
11. Soderstrom CE. Diagnostic significance of CSF spectrophotometry and computer tomography in cerebrovascular disease. A comparative study in 231 cases. *Stroke* 1977;8(5):606-12.
12. Hillman J. Should computer tomography scanning replace lumbar puncture in the diagnostic process in suspected subarachnoid hemorrhage? *Surg Neurol* 1986;26:547-50.
13. Duffy GP. Lumbar puncture in spontaneous subarachnoid hemorrhage. *BMJ* 1982;285:1163-4.
14. MacDonald A, Mendelow AD. Xanthochromia revisited: a re-evaluation of lumbar puncture and ct scanning in the diagnosis of subarachnoid hemorrhage. *J Neurol Neurosurg Psychiatry* 1988;51:342-4.

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