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ONE MINUTE CONSULT
BRIEF ANSWERS TO SPECIFIC CLINICAL QUESTIONS

Q: When should brain imaging precede lumbar puncture in cases of suspected bacterial meningitis?

A: Brain imaging should precede lumbar puncture in patients with focal neurologic deficits or immunodeficiency, or with altered mental status or seizures during the previous week. However, lumbar puncture can be safely done in most patients without first obtaining brain imaging. Empiric antibiotic and corticosteroid therapy must not be delayed; they should be started immediately after the lumber puncture is done, without waiting for the results. If the lumbar puncture is going to be delayed, these treatments should be started immediately after obtaining blood samples for culture.

A MEDICAL EMERGENCY

Bacterial meningitis is a medical emergency and requires prompt recognition and treatment. It is associated with a nearly 15% death rate as well as neurologic effects such as deafness, seizures, and cognitive decline in about the same percentage of patients.[1] Microbiologic information from lumbar puncture and cerebrospinal fluid analysis is an essential part of the initial workup, whenever possible. Lumbar puncture can be done safely at the bedside in most patients and so should not be delayed unless certain contraindications exist, as discussed below.[2]

INDICATIONS FOR BRAIN IMAGING BEFORE LUMBAR PUNCTURE

Table 1 lists common indications for brain imaging before lumbar puncture. However, there is a lack of good evidence to support them.

Current guidelines on acute bacterial meningitis from the Infectious Diseases Society of America recommend computed tomography (CT) of the brain before lumbar puncture in patients presenting with:

- Altered mental status
- A new focal neurologic deficit (eg, cranial nerve palsy, extremity weakness or drift, dysarthria, aphasia)
- Papilledema
- Seizure within the past week
- History of central nervous system disease (eg, stroke, tumor)
- Age 60 or older (likely because of the association with previous central nervous system disease)
- Immunocompromised state (due to human immunodeficiency virus infection, chemotherapy, or immunosuppressive drugs for transplant or rheumatologic disease)
- A high clinical suspicion for subarachnoid hemorrhage.[3–5]

However, a normal result on head CT

TABLE 1
Common indications for brain imaging before lumbar puncture

Altered mental status
Focal neurologic deficits
Seizures within 1 week
Papilledema
Immunodeficiency
History of central nervous system disease
Age ≥ 60
High clinical suspicion for subarachnoid hemorrhage

Antibiotic and corticosteroid treatment must not be delayed by imaging studies

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TABLE 2

General contraindications to lumbar puncture

Skin infection at the puncture site
Spine infection at the puncture site
Thrombocytopenia (platelet count < 50×10^9/L) or use of antithrombotic agents other than aspirin
Coagulopathy (international normalized ratio > 1.4) or use of anticoagulants

does not rule out the possibility of increased intracranial pressure and the risk of brain herniation. Actually, patients with acute bacterial meningitis are inherently at higher risk of spontaneous brain herniation even without lumbar puncture, and some cases of brain herniation after lumbar puncture could have represented the natural course of disease. Importantly, lumbar puncture may not be independently associated with the risk of brain herniation in patients with altered mental status (Glasgow Coma Scale score ≤ 8).[6] A prospective randomized study is needed to better understand when to order brain imaging before lumbar puncture and when it is safe to proceed directly to lumbar puncture.

A normal result on head CT does not rule out increased intracranial pressure and risk of brain herniation

CONTRAINDICATIONS TO LUMBAR PUNCTURE

General contraindications to lumbar puncture are listed in **Table 2**.

Gopal et al[3] analyzed clinical and radiographic data for 113 adults requiring urgent lumbar puncture and reported that altered mental status (likelihood ratio [LR] 2.2), focal neurologic deficit (LR 4.3), papilledema (LR 11.1), and clinical impression (LR 18.8) were associated with abnormalities on CT.

Hasbun et al[4] prospectively analyzed whether clinical variables correlated with abnormal results of head CT that would preclude lumbar puncture in 301 patients requiring urgent lumbar puncture. They found that age 60 and older, immunodeficiency, a history of central nervous system disease, recent seizure (within 1 week), and neurologic deficits were associated with abnormal findings on head CT (eg, lesion with mass effect, midline shift). Importantly, absence of these characteristics had a 97% negative predictive value for abnormal findings on head CT. However, neither a normal head CT nor a normal clinical neurologic examination rules out increased intracranial pressure.[4,7]

CHIEF CONCERNS ABOUT LUMBAR PUNCTURE

Lumbar puncture is generally well tolerated. Major complications are rare[2] and can be prevented by checking for contraindications and by using appropriate procedural hygiene and technique. Complications include pain at the puncture site, postprocedural headache, epidural hematoma, meningitis, osteomyelitis or discitis, bleeding, epidermoid tumor, and, most worrisome, brain herniation.

Brain herniation

Concern about causing brain herniation is the reason imaging may be ordered before lumbar puncture. Cerebral edema and increased intracranial pressure are common in patients with bacterial meningitis, as well as in other conditions such as bleeding, tumor, and abscess.[1] If intracranial pressure is elevated, lumbar puncture can cause cerebral herniation with further neurologic compromise and possibly death. Herniation is believed to be due to a sudden decrease in pressure in the spinal cord caused by removal of cerebrospinal fluid. However, the only information we have about this complication comes from case reports and case series, so we don't really know how often it happens.

On the other hand, ordering ancillary tests before lumbar puncture and starting empiric antibiotics in patients with suspected bacterial meningitis may delay treatment and lead to worse clinical outcomes and thus should be discouraged.[8]

Also important to note is the lack of good data regarding the safety of lumbar puncture in patients with potential hemostatic problems (thrombocytopenia, coagulopathy). The recommendation not to do lumbar puncture in these situations (**Table 1**) is taken from neuraxial anesthesia guidelines.[9] Further, a small retrospective study of thrombocytopenic oncology patients requiring lumbar puncture did not demonstrate an increased risk of complications.[10]

ADDITIONAL CONSIDERATIONS

In a retrospective study in 2015, Glimåker et al[6] demonstrated that lumbar puncture without prior brain CT was safe in patients with suspected acute bacterial meningitis with moderate to severe impairment of mental status, and that it led to a shorter "door-to-antibiotic time." Lumbar puncture before imaging was also associated with a concomitant decrease in the risk of death, with no increase in the rate of complications.[6]

If brain imaging is to be done before lumbar puncture, then blood cultures (and cultures of other fluids, whenever appropriate) should be collected and the patient should be started on empiric management for central nervous system infection first. CT evidence of diffuse cerebral edema, focal lesions with mass effect, and ventriculomegaly should be viewed as further contraindications to lumbar puncture.[1]

Antibiotic therapy

When contraindications to lumbar puncture exist, the choice of antibiotic and the duration of therapy should be based on the patient's history, demographics, risk factors, and microbiologic data from blood culture, urine culture, sputum culture, and detection of microbiological antigens.[1] The choice of antibiotic is beyond the scope of this article. However, empiric antibiotic therapy with a third-generation cephalosporin (eg, ceftriaxone) and vancomycin and anti-inflammatory therapy (dexamethasone) should in most cases be started immediately after collecting samples for blood culture and must not be delayed by neuroimaging and lumbar puncture with cerebrospinal fluid sampling, given the high rates of mortality and morbidity if treatment is delayed.[5,8]

Consultation with the neurosurgery service regarding alternative brain ventricular fluid sampling should be considered.[11]

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