Diagnostic lumbar puncture: minimizing complications

J. Williams,¹ D. C. B. Lye¹ and T. Umapathi²

¹Department of Infectious Diseases, Tan Tock Seng Hospital and ²Department of Neurology, National Neuroscience Institute, Singapore

Abstract

Diagnostic lumbar puncture (LP) is essential to the diagnosis of central nervous system infections and subarachnoid haemorrhage. Life or limb-threatening adverse events due to the procedure are rare, but less severe complications may be common. Clinical practice in diagnostic LP is often not evidenced based. The aim of the study was to use best available published evidence to address questions on minimizing complications associated with diagnostic LP. We searched PubMed for studies in the English language using key words relevant to the complications of diagnostic LP. We emphasized randomized controlled trials and systematic reviews enrolling adult patients undergoing diagnostic LP. Uncontrolled studies and studies involving children or spinal anaesthesia were considered when no other evidence was available. There were nine prospective studies and three systematic reviews on reducing complications from LP. Recommendations on interventions to minimize complications of LP are graded based on the quality and strength of evidence.

Introduction

Emergent lumbar puncture (LP) is commonly carried out to investigate possible central nervous system infection or subarachnoid haemorrhage (SAH). Clinical practice in diagnostic LP is often not compatible with current published evidence.¹,² This review uses published evidence to answer questions frequently raised in clinical practice. We evaluated studies examining measures to reduce complications of LP.

Methods

We searched PubMed for studies and meta-analyses published in English using the search terms: ‘dural puncture’, ‘lumbar puncture’, ‘cerebrospinal fluid’, ‘headache’, ‘diagnosis’, ‘sitting’, ‘bevel’, ‘stylet’, ‘bacteremia’, ‘infection’, ‘aspirin’, ‘heparin’, ‘warfarin’ and ‘meningitis’. Bibliographies of retrieved studies were examined for further eligible studies. For interventional studies we emphasized randomized controlled trials (RCT) that enrolled adult patients. Dural puncture for spinal anaesthesia differs from diagnostic LP as needles are usually smaller and less cerebrospinal fluid (CSF) is removed. Uncontrolled studies and studies involving children or spinal anaesthesia were considered when no other evidence was available.

Reducing complications

Does routine computed tomography brain before LP prevent cerebral herniation in adults with suspected meningitis?

Routine computed tomography (CT) before LP is often requested, but may significantly delay it. Ideally LP should occur before initiation of antibiotics, but should not delay antibiotic therapy. Delay in initiation of antibiotics was associated with increased risk of adverse outcome and death.³ There are no reports of serious deterioration post-LP in patients neurologically normal before the procedure.⁴ Two prospective studies of patients undergoing LP for suspected meningitis evaluated the need for prior CT and concluded that clinical examination predicted the finding of abnormalities on CT.⁵,⁶ The absence of immunocompromised status, recent seizure, decreased consciousness and

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focal neurology made finding abnormalities on CT extremely unlikely (negative predictive value 97%). The few patients whose abnormalities were missed by clinical assessment underwent LP with no complications.

How can we reduce the incidence of post-LP headache

The incidence of post-LP headache (PLPH) varied from 1 to 70%. PLPH is thought to result from chronic CSF leakage, leading to low CSF pressure and traction on the meninges and intracranial veins. Onset is usually within 48 h and resolves spontaneously within a few days. However, it may be disabling, necessitating hospital admission.

Does bedrest post-LP reduce the incidence of PLPH?

Two systematic reviews addressed this question. One considered studies examining dural puncture carried out for myelography, diagnosis and anaesthesia (n = 1254). It found a non-significant trend towards increased PLPH for patients randomized to bedrest versus patients allowed to mobilize early (odds ratio (OR) 1.21; 95% confidence interval (CI) 0.94–1.55). A similar result was found when only the five studies examining diagnostic LP were considered (n = 304) (OR 1.18; 95%CI 0.82–1.69). The second review analysed an additional two studies examining headache, post-diagnostic dural puncture (n = 658) and again found no significant difference in PLPH in early mobilization versus bedrest (relative risk (RR) 0.97; 95%CI 0.79–1.19).

Does the type of needle used affect the incidence of PLPH?

Five prospective controlled trials examined this question. Lavi et al. randomized 58 patients undergoing diagnostic or therapeutic LP to either conventional cutting or atraumatic 22-G needles. The incidence of PLPH was higher in the conventional needle group than the atraumatic group (36 vs 3%, P = 0.002). Thomas et al. found a similar result after randomizing 101 patients to diagnostic LP with either atraumatic or conventional needles. After 7 days of follow up, moderate to severe headache was reduced by 26% (95%CI 6–45%) in the atraumatic group. Braune and Huffmann randomized 75 patients to 22-G atraumatic or conventional needles and found a reduced incidence of PLPH in the atraumatic group (4 vs 36%, P < 0.05). The remaining two trials were potentially biased by comparing 22-G atraumatic needles with 20-G conventional needles. Both found lower rates of PLPH with the smaller atraumatic needle (6 vs 32% (P = 0.001) and 5 vs 31% (P = 0.001)).

Does the gauge of needle affect incidence of PLPH?

No controlled trials compared needles of identical design but different gauges on the incidence of PLPH. Uncontrolled studies suggested larger diameter needles were associated with higher incidence of PLPH. For diagnostic LP, needles smaller than 22-G may be impractical as CSF flow is slow and measuring CSF pressure and collecting adequate CSF volumes for diagnosis may be difficult.

Does bevel orientation affect the incidence of PLPH?

A meta-analysis of trials comparing insertion of a cutting needle with the bevel orientated parallel/longitudinal with insertion in a perpendicular/transverse direction found that parallel/longitudinal insertion resulted in significantly lower incidence of PLPH (10.9 vs 25.8%; OR 0.29; 95%CI 0.17–0.50).

Does replacing the stylet before withdrawing the needle reduce the incidence of PLPH?

A single prospective randomized trial addressed this question. Six hundred patients undergoing diagnostic LP with 21-G atraumatic needles were randomized to the stylet being replaced before removal of needle or the needle being removed without the stylet in place. Patients were blinded and were followed up for 7 days. Forty-nine of 300 patients (16%) without reinsertion developed PLPH versus 5% with stylet reinserted (P < 0.005).

How can we maximize the chance of a successful LP?

Is lateral recumbent or sitting position optimal for successful LP?

No controlled studies compared success of diagnostic LP with sitting or recumbent position. One small study found a significantly increased interspinous distance on ultrasound with patients sitting with feet supported compared with patients in the lateral recumbent position (2.02 vs 1.91 cm; 95%CI 0.07–0.14). The lateral recumbent position allows accurate measurement of CSF opening pressure.

Does type of needle affect the chance of a failed attempt at LP?

We found three prospective studies comparing incidence of PLPH with conventional or atraumatic needles that reported number of attempts needed as a secondary outcome.
One study randomized 100 patients to atraumatic 22-G or conventional 20-G needles. Eleven of 50 patients in the standard group and 16 of 50 in the atraumatic group required more than one attempt (RR 1.12; 95%CI 0.90–1.46). Another study compared identical needles and noted 3 of 49 patients in the atraumatic group and 3 of 50 patients in the conventional group required a second attempt (RR 1.00; 95%CI 0.9–1.1). All second attempts were successful with the same needle. A study comparing 20-G atraumatic and conventional needles found that 11 of 48 patients in the conventional group needed more than one attempt versus 18 of 49 patients in the atraumatic group (RR 1.6; 95%CI 0.8–4.75).

How can we minimize the incidence of infection post-LP?

Iatrogenic meningitis is an uncommon complication of diagnostic LP. Incidence is unclear because cases may not be reported. Physicians may not be aware of the potential association between meningitis and a preceding LP. Potential routes of infection include from operators’ hands, the patient’s skin or through aerosolization of organisms from the operator’s mouth. In a review of 179 cases of postdural puncture meningitis, only 9% followed diagnostic LP; most followed either spinal or epidural anaesthesia.

Should operators wear masks when carrying out diagnostic LP?

We found no studies that looked at whether the use of masks reduced the incidence of postdural puncture headache. The incidence of postdural puncture headache is so low that studies to answer this question would need to enrol enormous numbers of participants and are therefore impractical. Identical Streptococci have been isolated from the CSF of a patient with post-LP meningitis and from the operator’s oropharynx. Masks have been shown to reduce dispersal of methicillin-resistant *Staphylococcus aureus* (MRSA), but not other bacteria, from MRSA colonized staff. Masks are often not worn by those who frequently carry out LP.

Should LP be avoided in patients with suspected bacteraemia?

It is theoretically possible for LP to cause meningitis in a bacteraemic patient. A retrospective study of 1089 bacteraemic infants found no significant difference in the incidence of subsequent meningitis between infants undergoing LP and those that did not.

How can bleeding complications be minimized?

Although extremely rare, epidural, subdural haemorrhage or SAH is a potentially devastating complication of LP. Emergent LP may be indicated in patients receiving aspirin, warfarin or heparin.

Is antiplatelet therapy a contraindication to LP?

One study found a significantly higher incidence of haemorrhage in patients anticoagulated after LP. A prospective study of 1000 orthopaedic procedures carried out under spinal or epidural anaesthesia included 386 patients who were taking antiplatelet agents before surgery. Aspirin was the commonest agent taken by 193 patients. No spinal haematoma occurred. Bleeding was noted during catheter placement in 223 patients, but preoperative antiplatelet therapy was not found to be a risk factor. Stopping aspirin may be hazardous to patients although the magnitude of the increased risk is unclear. Up to 10.2% of myocardial infarction occurred after aspirin withdrawal.

Is anticoagulation with warfarin or heparin a contraindication to LP?

No randomized controlled trials evaluated stopping heparin or warfarin before diagnostic LP. One observational study evaluated 25 patients with normal pressure hydrocephalus who underwent therapeutic LP while taking warfarin. Warfarin was stopped 5–7 days before LP and no bleeding occurred. Guidelines suggest stopping low-dose low-molecular-weight heparin (LMWH) 12 h and high dose 24 h before spinal anaesthesia.

**Recommendations**

These are based on the studies discussed here. Grading follows the system described by the Infectious Diseases Society of America with ‘I’ indicating evidence from >1 RCT, ‘II’ indicating evidence from >1 well designed clinical trial and III indicating expert opinion. The strength of recommendation is indicated by ‘A’ to ‘E’ with ‘A’ indicating good evidence to support a recommendation, ‘B’ indicating moderate supporting evidence and ‘C’ indicating that the evidence in support of recommendations is poor. ‘D’ and ‘E’ indicates moderate and strong evidence against use, respectively.

- Routine CT brain before LP is not indicated (IA)
- Post-LP, patients may mobilize when ready (IA)
- Diagnostic LP should be carried out with 20-G or 22-G atraumatic needles (IA)
• If conventional needles are used the bevel should be orientated parallelly/longitudinally (IA)
• The stylet should be replaced before withdrawing the needle (IA)
• Diagnostic LP should be carried out in the lateral recumbent position to enable measurement of opening pressure (IIIC)
• A mask should be worn for diagnostic LP if the procedure is expected to be prolonged or difficult or if the operator has an upper respiratory tract infection (IIIC)
• Suspected bacteraemia is not a contraindication to LP (IIIC)
• Aspirin is not a contraindication to emergent LP. For elective LP the low risk of serious bleeding if aspirin is continued must be balanced against the increased risk of cardiovascular or cerebrovascular events if aspirin is stopped (IIIB)
• Clotting abnormalities should be corrected before emergent LP. LP appears safe if long-term warfarin is stopped (IIIB)
• Aspirin is not a contraindication to emergent LP. For elective LP the low risk of serious bleeding if aspirin is continued must be balanced against the increased risk of cardiovascular or cerebrovascular events if aspirin is stopped (IIIB)
• Aspirin is not a contraindication to emergent LP. For elective LP the low risk of serious bleeding if aspirin is continued must be balanced against the increased risk of cardiovascular or cerebrovascular events if aspirin is stopped (IIIB)

References