

# Post-Lumbar Puncture Headache

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Lumbar puncture is a common procedure performed for diagnostic, anesthetic, and obstetric purposes; however, up to one third of patients may experience headache after the procedure.<sup>1,2</sup> In 1898, Bier was the first to report on post-lumbar puncture headache (PLPH) after he and his associates underwent lumbar puncture themselves and experienced headaches first-hand. Bier postulated that PLPH was caused by leakage of cerebrospinal fluid (CSF) through the puncture in the dura mater caused by the needle.<sup>3</sup>

A recent report from the American Academy of Neurology estimated that PLPH occurs in 13% to 32% of all patients who undergo lumbar puncture.<sup>4</sup> Risk factors for PLPH include young age (18–32 yr), female gender (occurs nearly 2.5 times more often in women), history of previous PLPH, low body mass index, and type and size of the needle used for performing the procedure.<sup>2</sup> Physicians should be aware of the methods for performing lumbar puncture that have been shown to minimize the occurrence of PLPH and should be able to treat this complication appropriately when it does occur. Although PLPH can resolve on its own, supportive measures such as analgesics and antiemetics are often warranted; if the headache does not respond to these measures, more invasive procedures such as epidural blood patch (EBP) or epidural saline injection may be used. This article reviews methods that have been shown to reduce the frequency of PLPH and discusses therapeutic options for patients with PLPH.

## PATHOPHYSIOLOGY

The spinal dura mater is a membrane comprised of collagen fibers extending from the foramen magnum to the second sacral segment. The spinal dura mater contains the spinal cord and is pierced intermittently by nerve roots. Although the pathophysiology of PLPH is still unclear, it is thought to develop as a result of leakage of CSF through the dural puncture. Continuous leakage of CSF leads to decreased CSF pressure and volume; however, the relationship between lower CSF pressure and volume and PLPH is unclear. One theory suggests that the loss of CSF volume activates

## TAKE HOME POINTS

- Headache is a common complication of lumbar puncture and usually occurs within several days after the procedure.
- Risk factors for post-lumbar puncture headache (PLPH) include young age, female gender, history of previous lumbar puncture headache, and needle type and size.
- The headache in PLPH is positional and increases in severity upon sitting or assuming an upright posture. It is described as pressure-like pain with occasional throbbing, pounding, or a dull, aching quality.
- Prevention of PLPH is aimed at limiting the cerebrospinal fluid leak at the site of the lumbar puncture.
- Treatment for PLPH consists of conservative measures such as analgesics and antiemetics. If the headache does not respond to these measures, invasive procedures such as epidural blood patch or epidural saline injection may be used.

adenosine receptors, which leads to vasodilatation and headache.<sup>3,5</sup> The posterior dura mater is thicker than the anterior dura mater, but this thickness varies between patients. Lumbar puncture in thicker areas of the dura mater is less likely to lead to PLPH.<sup>3</sup>

## PREVENTION

Prevention of PLPH is aimed at limiting the CSF leakage following a lumbar puncture. There are several practices that traditionally had been thought to reduce the occurrence of PLPH but have been shown to be ineffective. Specifically, prolonged bed rest in the recumbent position following a lumbar puncture has

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been used to prevent PLPH. However, multiple studies have suggested that there is no benefit from this practice.<sup>6,7</sup> In addition, the amount of CSF removed is not associated with PLPH,<sup>2</sup> and increased hydration after the procedure has not been shown to be effective in reducing the incidence of PLPH.<sup>2</sup> Finally, studies have shown that the level of the operator skill does not affect the incidence of PLPH.<sup>2,8</sup>

Several factors have been shown to be important contributors to the risk for PLPH, including needle size and type. Small-bore (high-gauge) needles have been shown to reduce the risk of PLPH.<sup>4</sup> In a study that evaluated the role of needle diameter and tip configuration in the development of PLPH, a lower incidence of PLPH was seen when 27-gauge Quincke and 25-gauge Whitacre needles were used versus 26-gauge Quincke needles.<sup>9</sup> However, smaller needle sizes increase the failure rate of the lumbar puncture because they are more difficult to use.<sup>10,11</sup> As a result, needles smaller than 25 gauge are not preferred in spinal anesthesia.

Several types of needles are used for lumbar puncture, including Quincke, Whitacre, Sprotte, and Atraucan needles. Needles can be classified as "cutting" (ie, Quincke needle) or "atraumatic" (ie, Whitacre, Sprotte, Atraucan needles). It is thought that atraumatic needles separate the dural fibers rather than cut them, which may lead to a lower incidence of PLPH.<sup>8</sup> Several studies have shown that the frequency of PLPH is lower with the use of atraumatic needles, particularly the Sprotte needle, as compared with the Quincke needle.<sup>9,12-14</sup> One study comparing 5 spinal needles in obstetric patients failed to show the benefit of the Atraucan needle over other atraumatic needles.<sup>12</sup>

The American Academy of Neurology currently recommends the use of atraumatic needles for diagnostic lumbar puncture.<sup>15</sup> However, there is a learning curve for physicians who use atraumatic needles, and their use is associated with higher rates of failed lumbar puncture as compared with standard needles.<sup>14</sup> In addition, cost can be a factor for implementation of atraumatic needles at many institutions, as the cost of a Sprotte needle is approximately \$12 as compared with \$4 for a Quincke needle.<sup>4</sup>

Orientation of a Quincke needle perpendicular to the dural axis during lumbar puncture as compared with parallel orientation is associated with increased frequency of PLPH. In a randomized, double-blind study, patients who underwent lumbar puncture with a 27-gauge Quincke needle with the bevel of the needle perpendicular to the dural axis were almost 6 times more likely to experience PLPH (22.6% versus 3.8% in the parallel group).<sup>16</sup> However, needle orientation

is only a concern for cutting needles (eg, Quincke), as atraumatic needles split the dural fibers as opposed to cutting them.<sup>6</sup> Finally, for atraumatic needles, reinserting the stylet immediately before withdrawing the needle decreases the incidence of PLPH.<sup>4</sup>

## CLINICAL FEATURES AND DIAGNOSIS

PLPH usually starts within 48 hours after lumbar puncture but may be delayed for up to 14 days.<sup>1,3,8,17</sup> Pain occurs in the frontal and occipital areas but may radiate to the neck and shoulders.<sup>3,8,17</sup> The temporal, vertex, and nuchal areas are less commonly involved.<sup>3,8</sup> Headache is positional and increases in severity upon sitting or assuming an upright posture. Movement also worsens the headache. An increase in headache intensity when the patient sits up is characteristic of PLPH.<sup>3</sup>

The intensity of PLPH varies from mild to severe, with severe headache being more common.<sup>17</sup> It is described as pressure-like pain with occasional throbbing, pounding, or a dull, aching quality.<sup>8</sup> In addition to headache, patients with PLPH may experience photophobia, nausea, vomiting, neck stiffness, tinnitus, diplopia, and dizziness.<sup>5</sup> In a small percentage of patients, ocular and vestibular or cochlear symptoms may be seen.<sup>17</sup> The median duration of the headache is 5 days.<sup>3,17</sup> A headache that begins within the first 24 hours after lumbar puncture is usually more severe and longer lasting.<sup>8</sup>

The timing of the headache following lumbar puncture typically directs the physician towards the diagnosis. Patients with PLPH typically present with a history of a recent lumbar puncture followed by a postural headache that increases in severity upon sitting up. However, if headache starts within the first hour after the lumbar puncture, the physician should consider alternative diagnoses (**Table**). Computed tomography without contrast can help to rule out intracranial hemorrhage. CSF analysis can also exclude meningitis as a cause.<sup>3</sup>

## TREATMENT

If the headache is mild, supportive measures such as analgesics (eg, nonsteroidal anti-inflammatory drugs, opioids) and antiemetics should be used.<sup>3</sup> However, if the headache fails to respond to these nonspecific measures or if patients have moderate to severe headache, other pharmacologic therapy and more invasive procedures (eg, EBP, epidural saline injection) can be used to help resolve symptoms.

### Methylxanthines

Methylxanthines, such as caffeine and theophylline, have been shown to resolve symptoms of PLPH.

Caffeine, used either parenterally or orally, is one of the most common treatments for PLPH. Oral caffeine is absorbed within 15 to 45 minutes, crosses the blood-brain barrier, and has a long elimination half-life (3-7.5 hr), allowing for less frequent dosing. Parenteral caffeine is available in the form of caffeine sodium benzoate. The exact mechanism of action of caffeine in PLPH is unknown. PLPH is believed to be caused by adenosine-induced cerebral vasodilatation, and caffeine may act by antagonizing adenosine, thus leading to cerebral vasoconstriction.<sup>3,18</sup>

In a randomized, placebo-controlled study comparing 500 mg intravenous (IV) caffeine and IV saline in patients with PLPH, Sechzer and Abel<sup>19</sup> reported a 71% response rate in caffeine-treated patients. No major adverse reactions were reported. This finding was supported by Jarvis et al,<sup>20</sup> who reported a success rate of 75% with IV caffeine. Administration of IV caffeine is relatively inexpensive and less invasive compared with EBP. As a result, caffeine should be initiated before invasive treatment is considered. However, IV caffeine may not be universally available, and PLPH may recur after caffeine administration.<sup>3,6</sup>

Theophylline is thought to have the same mechanism of action as caffeine (ie, antagonizing adenosine thereby causing cerebral vasoconstriction) and is used in combination with aminophylline for the treatment of PLPH; however, it does not have a clear advantage over caffeine. Data to support the use of theophylline are limited, but it is more commonly available as compared with caffeine.<sup>18</sup>

### Sumatriptan

Sumatriptan, a 5-hydroxytryptamine<sub>1</sub> receptor agonist, acts by causing cerebral vasoconstriction. It is approved by the US Food and Drug Administration to treat migraine and is being explored for the treatment of PLPH. However, in a recent randomized, placebo-controlled study, sumatriptan failed to resolve PLPH symptoms in a majority of patients.<sup>21</sup> More studies are needed to confirm the efficacy of sumatriptan in this setting.

### Epidural Blood Patch

EBP is a procedure in which the patient is placed in a lateral position and autologous blood (10-15 mL) is injected epidurally at the puncture site of the prior lumbar puncture.<sup>3</sup> The therapeutic effect of EBP is believed to result from the injected blood forming a clot and sealing the puncture caused by the needle. An MRI study of 1 patient after EBP showed blood collected mainly in the posterior epidural space as well as blood spread of approximately 4.6 + 0.9 intervertebral

**Table.** Differential Diagnosis of Post-Lumbar Puncture Headache

Meningitis (viral, chemical, or bacterial)
Intracranial hemorrhage
Cerebral venous thrombosis
Intracranial tumor
Sinus headache
Migraine
Drugs (eg, caffeine, amphetamine)
Cerebral infarction
Preeclampsia
Uncal herniation
Pituitary apoplexy
Nonspecific headache

Adapted from Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention, and treatment. *Br J Anaesth* 2003; 91:722. By permission of Oxford University Press.

spaces, mostly in the direction of the head.<sup>22</sup> EBP also leads to a tamponade effect of the thecal sac.<sup>23</sup>

If the patient complains of pain in the back, legs, or buttocks, the EBP procedure should be stopped.<sup>3,24</sup> Level of discomfort is often used to titrate the amount of blood injected (ie, used as a volume endpoint).<sup>24</sup> After the EBP procedure, the patient should lie in a dorsal position for at least 1 hour. This positioning has been shown to statistically significantly increase the effectiveness of the EBP.<sup>25</sup> Contraindications to EBP include leukocytosis, fever, patient refusal, infection at local site, and technical difficulties. Exacerbation of the headache after treatment with EBP has been described.<sup>26</sup> Facial paralysis, vertigo, tinnitus, and ataxia have also occurred along with residual complications such as backache and/or stiffness.<sup>27</sup>

Studies have shown that the efficacy of EBP is between 75% and 96%.<sup>24,28</sup> A large, randomized, observer-blind trial is currently underway to further compare the efficacy of EBP and conventional treatment for PLPH.<sup>29</sup>

### Experimental/Unproven Therapies

**Epidural saline injection.** Epidural saline injection has been suggested as an alternative to EBP for treatment of PLPH. The epidural saline injection is thought to produce a therapeutic effect by increasing CSF pressure. However, studies evaluating the use of epidural saline injection are scarce. In an early study by Rice et al,<sup>30</sup> epidural saline injection in patients with PLPH had a 99.5% success rate and a 54% recurrence rate.

**Epidural dextran patch.** The epidural dextran patch works in the same way as epidural saline injection.

Because dextran is a larger molecule, it takes longer to be absorbed and cleared from the epidural space, which increases the onset of action. Use of the epidural dextran patch is not supported by strong evidence; thus, its use for the treatment of PLPH is not recommended at this time.<sup>3</sup>

**Other therapies.** Other potential treatments for PLPH include morphine sulfate, gelatin patch, fibrin glue, and surgery to close the dural puncture; however, more data are needed regarding their use in this setting.<sup>3,18</sup>

## CONCLUSION

PLPH is a common complication of lumbar puncture and usually occurs within several days after the procedure. Headache severity varies from mild to debilitating and severe, and it tends to be self-limiting in the majority of cases. Diagnosis is usually made by strong clinical suspicion and ruling out other possible causes. Measures can be undertaken to decrease the risk of PLPH, including use of atraumatic needles, use of smaller size needles, and aligning the needle bevel parallel to the dural fibers when performing the puncture. Although advances have been made in understanding the mechanism of PLPH, treatment remains a challenge. Mild PLPH can be treated by supportive measures, such as nonsteroidal anti-inflammatory drugs and antiemetics. If these measures fail to provide relief, oral or IV caffeine may be tried. EBP may be used in patients who do not respond to conservative measures. **HP**

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