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The Epidural Blood Patch: Beyond the Post-dural Puncture Headache

By Anna Fabrizi, MD

Anesthesiologists are often involved in the care of patients with post-dural puncture headaches (PDPH) after a diagnostic lumbar puncture, spinal anesthesia, or an unintentional breach of the dura mater during an epidural. One therapeutic option involves the application of a "blood patch" to seal the breach. For a number of years, however, anesthesiologists have been asked to contribute to the management of a recently recognized diagnostic entity called "spontaneous intracranial hypotension" (SIH). There are specific indications to perform a blood patch in patients with SIH. The purpose of this issue of *Anesthesiology Rounds* is to review the pathophysiology of PDPH and SIH, to describe the natural history of these conditions, and to describe the blood patch technique.

Lumbar punctures are used commonly for either diagnostic or therapeutic purposes, and the technique is frequent in the practice of anesthesia. PDPH occurs relatively commonly, but its clinical characteristics vary, which sometimes complicates diagnosis. Presentation is variable, and a blood patch is not the only therapeutic option. On the other hand, SIH is a clinical entity that was described only a few years ago, but it is becoming more and more widely recognized. It is the result of spontaneous breaches in the dura mater, and a blood patch is one of the treatments offered. Anesthesiologists are therefore asked to participate in the management of patients with SIH.

ANATOMICAL AND PHYSIOPATHOLOGICAL CONCEPTS

The dura mater is made up of layers of dense conjunctive tissue comprising elastic fibres and collagen. Classically, a longitudinal arrangement of the fibres in the rostrocaudal axis has been described, but recent studies have instead shown a non-specific orientation of the fibres. The thickness of the dura mater varies inconsistently with vertebral level, and there is significant variability among individuals. The cerebrospinal fluid (CSF) has a volume of approximately 150 mL, half of which is spinal and the other half inside the cranial cavity. The normal production is 0.35 mL/min, or approximately 500 mL/day, but it is reduced by dehydration, a febrile state, and certain drugs. The CSF pressure at the lumbar level is in the range of 5–15 cm H_2O in the decubitus position, and reaches >40 cm H_2O in the upright position.

A breach in the dura mater leads to a CSF leak into the epidural space, decreasing intrathecal pressure, which in turn can be detected as a sagging of the intracranial structures, as seen on magnetic resonance imaging (MRI), and meningeal enhancement due to vasodilatation. This traction on the cerebral structures could be the explanation for the headache, although some authors believe that the symptoms are due chiefly to the compensatory vasodilatation from the loss of CSF volume. Irrespective of which of these 2 mechanisms plays a major role, lying in the dorsal decubitus position reduces CSF leakage, brings the intracranial pressure back towards normal values, and alleviates the symptoms.

POST-DURAL PUNCTURE HEADACHE (PDPH)

Incidence and risk factors

In 1898, Bier described the use of cocaine in the subarachnoid space in 9 subjects, including himself. Six of these subjects experienced intense headaches and had to stay

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in bed for several days before their condition improved. It was later noted that 50% of the patients suffered from PDPH, but it was considered that symptoms subsided within 24 hours.[1,2] In 1956, after the introduction of finer needles (22G or 24G), the incidence decreased to 11%. Since then, the use of even smaller-gauge needles has contributed to a further reduction in the incidence of PDPH. It also appears that a pointed tip produces less PDPH than a bevelled tip (Table 1). These data contribute to the popularity of even finer "atraumatic" needles (conical tip, orifice on the side; eg, Whitacre or Sprotte) for spinal anesthesia, despite the disadvantage of a slow return of the CSF. Thus, there would only be small lesions on the dura mater. On the other hand, the neurology literature appears to recommend the use of thicker needles (≤22G) to promote CSF return and to allow intrathecal pressure measurement.[3] A recent survey showed that only 2% of American neurologists use atraumatic needles.[4,5]

The risk of PDPH appears to be higher in young adults, and declines with age. Some studies have shown that women are at greater risk, while others have shown these differences between sexes are less if age is taken into consideration.[6]

Prevention

It has been shown that reducing needle size and choosing atraumatic types reduce the incidence of PDPH. As well, some studies have shown that a correct bevel orientation has a positive effect. It is hypothesized that the introduction of a needle while the bevel is parallel to the rostrocaudal axis reduces the incidence of PDPH by cutting fewer fibres. As it is now known that the fibres tangle in a disorderly manner, this hypothesis cannot be the only explanation, but this technique is still recommended.[6] Furthermore, some studies have shown a beneficial effect from replacing the stylet inside the needle before it is removed. Finally, limiting the number of attempts may reduce injury to the dura mater, thus reducing CSF leaks.[1]

However, neither the position of the patient during the lumbar puncture, nor the volume drawn, nor the opening pressure have been associated with the occurrence of PDPH. Likewise, hydrating the patient or a dorsal decubitus position for an extended period of time after the puncture do not appear to effectively prevent PDPH.[7] In obstetrical clients, an incidence of PDPH of up to 70% has been reported after an accidental puncture of the dura mater with an epidural needle (16G to 18G). Several methods have been proposed to reduce this incidence, such as placing a catheter in the subarachnoid space (which could promote an inflammatory reaction and accelerate the healing of the dura mater), or even the prophylactic injection of blood into the epidural catheter. The data on this subject are conflicting, and there are no recommendations on this issue by any professional association.[8]

TABLE 1: Incidence of post-dural puncture headache (PDPH) according to size and shape of the needles used (adapted from Turnbull et al[2]).

Name	Shape	Gauge (G)	Incidence of PDPH (%)
Tuohy	Blunt bevel With orifice	16	70
Whitacre	Pointed tip Orifice on the side	20	2 - 5
Quinke	Sharp bevel With orifice	22	36
Whitacre	Pointed tip Orifice on the side	22	0.63 - 4
Sprotte	Conical tip Orifice on the side	24	0 - 9.6
Quinke	Sharp bevel With orifice	25	3 - 25
Whitacre	Pointed tip Orifice on the side	25	0 - 14.5
Quinke	Sharp bevel With orifice	26	0.3 - 20
Atraucan	Double bevel With orifice	26	2.5 - 4
Quinke	Sharp bevel With orifice	27	1.5 - 5.6
Whitacre	Pointed tip Orifice on the side	27	0%
Quinke	Pointed tip With orifice	29	0-2%
Quinke	Sharp bevel With orifice	32	0.4%

Clinical presentation and diagnosis

Diagnosis is based primarily on the temporal relationship between lumbar puncture, a technique that could harm the dura mater, and the onset of headaches. Approximately 90% of patients will experience symptoms within 72 hours following puncture and, more rarely, between 5 and 14 days. Headache sometimes occurs immediately after puncture of the dura mater, but because this is a rare event, other causes for the headache should be sought. Lumbar puncture-induced headaches are described by patients as different from their normal headaches, are moderate to severe in intensity, and with a frontal-occipital predominance. Neck stiffness, temporal or neck pains, and pains at the vertex

have also been described. A PDPH characteristically is worse when the patient is standing and becomes less severe or may even disappear completely upon lying down.[2] Also, pain is typically increased by coughing or any activity that increases intrathecal pressure. Other possible symptoms include nausea, vomiting, reduced hearing or tinnitus, dizziness, paresthesias, and limb pain. Major complications due to the displacement of the cerebral structures have been described. Visual disorders ranging from diplopia to transitory or permanent cortical blindness have been reported. Serious neurological problems, such as epilepsy, subdural hematomas, herniation with cerebral involvement, and even death may also occur following lumbar puncture. The symptoms of mild PDPH, in the absence of treatment, persist for fewer than 10 days (90% of patients); however, cases have been described where the duration has extended to weeks, or even months.

In the case of headaches without postural involvement or atypical symptoms, such as fever, the differential diagnosis to consider includes meningitis, cerebral vein thrombosis, intracranial tumor, migraines, and preeclampsia.

To aid in clinical decision-making, the International Headache Society has proposed diagnostic criteria based on the characteristics of the symptoms, the temporal relationship between these symptoms and dural puncture, and progression of the symptoms (Table 2).[9] If the diagnosis is uncertain, additional testing is recommended. An MRI should show sagging of the cerebral structures, with or without meningeal enhancement. A lumbar puncture will show decreased or zero opening pressure, as well as slight increases in proteins and lymphocytes in the CSF.[2]

TABLE 2: International Headache Society diagnostic criteria for PDPH[9]

A. Headache that worsens within 15 minutes after sitting or standing and improves within 15 minutes after lying, with at least one of the following and fulfilling criteria C and D:
   1. neck stiffness
   2. tinnitus
   3. hypacusia
   4. photophobia
   5. nausea

B. Dural puncture has been performed

C. Headache develops within 5 days after dural puncture

D. Headache resolves either:[a]
   1. spontaneously within 1 week
   2. within 48 hours after effective treatment of the spinal fluid leak (usually by epidural blood patch)

[a] In 95% of cases this is so. When headache persists, causation is in doubt.

SPONTANEOUS INTRACRANIAL HYPOTENSION (SIH)

Incidence and risk factors

Although SIH was first described as long ago as 1938 and the syndrome has been recognized for about 20 years, an erroneous initial diagnosis remains common.[10] The annual incidence is approximately 5 cases per 100,000, which corresponds to about half the frequency of subarachnoid hemorrhages. Women are more affected than men, by a ratio of 2:1. Symptoms present most frequently during the fourth and fifth decades of life, but children and the elderly may also be affected.

The cause of spontaneous leakage of CSF is unknown, but it is presumed to be secondary to structural weaknesses. Several hypotheses have been proposed, including a viral origin, but most involve pathologies of the connective tissue. Indeed, two-thirds of patients present with connective tissue symptoms, such as ligmental hyperlaxity, a history of spontaneous retinal detachment, or Marfan or Ehlers-Danlos syndrome. A history of trauma, sometimes minor (coughing, heavy lifting, sports activities), is found in approximately one-third of the patients. In rare cases, skeletal pathologies, such as osteophytes or a protruding disk, are the cause of the breach in the dura mater. The leak may occur at any level of the spine, but is most often in the thoracic portion.

Clinical presentation

The typical manifestation of SIH is an orthostatic headache, generally appearing 15 minutes after standing. The International Headache Society has established diagnostic criteria for headaches induced by CSF leaks and SIH (Table 3).[9] Several other symptoms have been described in the context of SIH, and it seems that the orthostatic aspect is less predominant when it is chronic.

Diagnosis

In a patient with SIH, an MRI typically shows pachymeningeal enhancement. This enhancement may be linear, bilateral, infra- or supra-tentorial, and have a variable thickness, but is without leptomeningeal repercussion.[10] Also, sagging of the brain may mimic a type 1 Chiari malformation. Sub-

dural fluid accumulation is frequent. Despite these findings, MRI rarely shows the location of the leak at the spinal level; this level of detail requires more invasive techniques, such as isotopic cisternography (Indium 111) or myelography. These techniques involve a puncture of the dura mater; however, some authors caution that this may aggravate symptoms although this worsening might be significant in only 5% of patients.[11] There is no consensus on the sequence of diagnostic modalities, and MRI is the preferred test by some groups when treatment is initiated.[12]

TREATMENT AND BLOOD PATCH TECHNIQUES

Post-dural puncture headache

Although most symptoms resolve spontaneously after a few days, it must be recognized that patients are impaired significantly in their daily activities and there is a risk of major complications. Therefore effective treatment is required. The first step consists in addressing patient anxiety and stress related to the PDPH. Also, in view of the iatrogenic aspect of PDPH, the medico-legal context cannot be neglected, and it is necessary to proceed quickly.

Symptomatic treatment includes bed rest, rehydration, nonsteroidal anti-inflammatory drugs, acetaminophen, and anti-nausea drugs. Also, caffeine (300–500 mg twice daily) has been shown to be effective by favouring cerebral vasoconstriction and increased production of CSF. These methods may control symptoms and bring about spontaneous resolution of the breach, but do not treat the underlying etiology.

The only currently accepted etiological treatment is an epidural blood patch. This procedure consists in injecting autologous blood into the epidural space, usually at the same level where the lumbar puncture was performed. The main explanation for the benefit is that the clot thus produced seals the opening that is responsible for the leakage of CSF. However, this theory is questioned by the finding that a blood patch in the lumbar region has been shown to be effective in cases of SIH in which the breaches are located at the thoracic or even at the cervical level. The symptoms are usually lessened within minutes after a blood patch, possibly because of the compression of the dural sac, which would thus increase the CSF pressure. Moreover, the injected blood would favour scar formation and fibroblastic activity, which would explain its long-term effectiveness.

TABLE 3: Diagnostic criteria of spontaneous intracranial hypotension according to the International Headache Society[9]

A. Diffuse and/or dull headache that worsens within 15 minutes after sitting or standing, with at least one of the following and fulfilling criterion D:
   1. neck stiffness
   2. tinnitus
   3. hypacusia
   4. photophobia
   5. nausea

B. At least one of the following:
   1. evidence of low CSF pressure on MRI (eg, pachymeningeal enhancement)
   2. evidence of CSF leakage on conventional myelography, CT myelography or cisternography
   3. CSF opening pressure <60 mm H_2O in sitting position

C. No history of dural puncture or other cause of CSF fistula

D. Headache resolves within 72 hours after epidural blood patch

Until now, there have been few studies showing that a blood patch is better than symptomatic treatment in cases of PDPH. However, a prospective, observational study involving 504 patients over 12 years showed complete symptom resolution after a blood patch in 75% of patients, and partial relief in 18%.[13] In the 7% in whom the technique failed, 19 underwent a second procedure; 10 subjects (ie, >50%) experienced complete symptom relief, 7 reported partial relief, and 2 experienced no relief of symptoms.

However, there are few randomized studies on the effectiveness of this therapeutic intervention. The difficulty of carrying out double-blind studies is one of the most important factors. In one recently published study, patients presenting within 24 hours following onset of PDPH were randomized either to a symptomatic treatment (n=16) or to a blood patch (n=16).[14] Headache intensity was measured on a visual analogue scale (0–10) at 2 and 24 hours post-treatment. Pain intensity in the blood patch group was reduced from 8 to 1 after 24 hours compared with no improvement in the control group (P<0.0001). The optimal time to perform a

blood patch appears to be within 24 hours following the puncture; however, treatment success has been reported up to 12 months after the onset of symptoms. Moreover, if a second blood patch is necessary, then it is suggested to wait 48–72 hours after the first procedure.

Spontaneous intracranial hypotension

As in cases of PDPH, patients suffering from SIH may be offered several symptomatic treatments (hydration, analgesics, caffeine, etc.), and a number of patients will experience spontaneous resolution. A blood patch is now considered to be the primary treatment of SIH, and is sometimes also used as a diagnostic tool if symptoms improve after it is performed.[10-12] In a series of 30 patients, Berroir et al.[12] demonstrated the effectiveness of a first lumbar blood patch in 90% of patients, regardless of the site of the CSF leak. Despite the initial improvement of symptoms, 20% of patients required a second procedure. A total of 77% of patients obtained significant relief. It should be noted that 20–40 mL of blood were used in these patients, which may explain a higher success rate than what had been previously published.[12]

Some case-control articles have reported the effectiveness of targeted blood patches at the location of the leakage. However, because of the associated risk of spinal cord compression, this technique is not recommended at the thoracic or cervical level as first-line therapy. In refractory cases, a multidisciplinary team decision (neurology, neurosurgery, radiology, and anesthesiology) should be made before proceeding to a riskier technique. Also, a surgical approach may be considered in the event of the non-resolution of symptoms.

Technical aspects

A blood patch procedure is carried out in the same way as a standard epidural technique. The anesthesiologist may place the patient in the lateral decubitus or sitting position and will, after strict asepsis, look for a loss of resistance at the level of the previous lumbar puncture or one level below, if possible. An assistant draws blood under sterile conditions for injection into the epidural space. The ideal blood volume to inject is approximately 20 mL, and injection should be discontinued if the patient complains of lumbar pain or paresthesia. Higher volumes have been described in cases of SIH. Once the injection has been completed, the patient should remain supine for 2 hours before standing up progressively. The patient will also be asked to abstain from physical activity to prevent an increase in CSF pressure, and stool softeners may be required. It is usually necessary to rest for 2–4 hours before resuming daily activities.

Contraindications to a blood patch include coagulopathy, sepsis, puncture site infection, blood cancer with risk of seeding of the intrathecal space, and patient refusal. Seropositivity for the human immune deficiency virus is not a contraindication for a blood patch in the absence of active bacterial or viral pathology. The most current complications of a blood patch are pain at the injection site, accidental puncture of the dura mater, irradiating pain, and the inability to find the epidural space. Serious complications are rare, but some cases of cauda equina syndrome with permanent paraplegia, sinus thrombosis, and aseptic arachnoiditis have been described. It is therefore important to inform patients about the possible complications of the technique. The administration of inert solutions, such as normal saline, dextran, or even biological adhesive, is not recognized as having a benefit compared with injection of blood, and is used only in rare occasions. As a last resort, some cases have been treated surgically.[2]

CONCLUSION

PDPH is an iatrogenic complication of techniques involving a breach of the dura mater. In view of the frequency of this complication, it is of paramount importance for patients to be informed of this risk. This condition should be suspected in patients who present with a headache within days or weeks of a diagnostic or therapeutic technique involving a dural puncture. Screening is important to prevent catastrophic complications from cerebral hypotension. Symptomatic or etiological therapeutic approaches are available. A clinical picture similar to PDPH may appear without a puncture of the dura mater in cases of spontaneous intracranial hypotension. This increasingly recognized clinical entity requires the involvement of the anesthesia team for treatment of the underlying cause.

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Abstract of Interest

Post dural puncture headache (PDPH) represents a complication of anesthesia (with an increased incidence in obstetric patients) or as the consequence of a diagnostic lumbar puncture. The aim of the present study was to evaluate the efficacy of the epidural blood-patch (EBP) versus the conventional medical treatment of post-anesthetic headaches also including the PDPH following a diagnostic puncture, a category of patients rarely referred to the anesthesia consultation in our hospital because it was believed that they might have equal benefit from conventional measures due to the smaller size of needles used. We studied in a prospective, randomized, double-blinded manner 32 obstetric and non-obstetric patients with PDPH having the onset of the symptoms 24 hours before the inclusion in the study. The patients were randomly divided in two groups: group A (16 patients) receiving conventional treatment (oral and intravenous fluid replacement, non-steroidal anti-inflammatory drugs--NSAIDs--, caffeine) and group B (16 patients) in whom an epidural blood-patch was performed. The intensity of the headache was evaluated using a visual analogue scale (VAS) from 0-10, before, 2 hours and 24 hours after the EBP. There were no statistical differences concerning the demographic data and the cause of PDPH between the groups ($p > 0.05$). The intensity of PDPH was similar before performing the EBP ($p > 0.05$), with a value on VAS of 8.2 +/- 1,4. in group A and 8,0 +/- 1.6 in group B. Two hours after the treatment, the intensity of headache on VAS diminished extremely significant ($p < 0.0001$): in group B the value was 1.0 +/- 0,18 versus 8.2 +/- 1.4 in group A. The difference recorded after 24 hours remained statistically significant ($p < 0.0001$): the VAS scores were 0.7 +/- 0,16 and 7.8 +/- 1.2 respectively. The epidural blood patch represents the first choice treatment of PDPH no matter the etiology, being significantly superior to the conventional treatment which did not affect pain scores. In severe PDPH there is no reason to delay the EBP more than 24 hours after the diagnosis as all except two patients of the conventional treatment group required blood patching following the study period.

Sandesc D, Lupei MI, Sirbu C, Plavat C, Bedreag O, Vernic C. Conventional treatment or epidural blood patch for the treatment of different etiologies of post dural puncture headache. *Acta Anaesthesiol Belg*. 2005;56(3):265-269.

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