Best Practice & Research Clinical Anaesthesiology xxx (xxxx) xxx

Contents lists available at ScienceDirect

Best Practice & Research Clinical Anaesthesiology

journal homepage: www.elsevier.com/locate/bean

Post-dural puncture headache diagnosis and management

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Keywords:
post-dural puncture headache
epidural blood patch
neuraxial analgesia/anesthesia
complications
neuraxial

Epidural analgesia, commonly used to alleviate labor pain, is not without complication. The most common complication associated with labor epidural analgesia (LEA) is Unintentional Dural Puncture (UDP), where many professionals go on to develop a Post Dural Puncture Headache (PDPH). Spinal anesthesia can also result in PDPH. Other complications of dural puncture necessitating further treatment include hospital readmission, persistent headache, persistent backache, cerebral venous thrombosis, subdural hematoma, postpartum depression, post-traumatic stress disorder, and decreased maternal breastfeeding. In this article, we will define and discuss the definition and diagnosis for PDPH, the pathophysiology of PDPH, PDPH treatment options including conservative therapy, pharmacologic therapy, and invasive procedural measures including the therapeutic epidural blood patch, prophylactic epidural blood patch, intrathecal catheter placement after UDP, and potential new therapies.

Abbreviations: HA, headache; EBP, epidural blood patch; UDP, unintentional dural puncture; SIH, Spontaneous Intracranial Hypotension; aOR, adjusted Odds Ratio.

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https://doi.org/10.1016/j.bpa.2022.01.002
1521-6896/

Introduction

Post-dural puncture headache (PDPH) is the most common serious complication in obstetric anesthesia and new evidence indicates a parturient with a dural puncture that develops a headache may have short- and long-term consequences. An obstetric patient has a greater risk for PDPH compared to the non-obstetric or older patient populations. Approximately 140 million births per year worldwide [1] and the epidural analgesia utilization rate ranging in high-income countries from 19% in England to 83% in Finland [2] represent over 100,000 [3,4] women worldwide who need to be evaluated and followed for potential PDPH [3,4]. While the traditional view has been that PDPH can be a severe, debilitating short-term headache with a rare chance of more serious complications, several new studies have indicated an increased risk of intermediate and longer-term effects at 1-year postpartum including chronic backache and headache, decreased breastfeeding rates, and post-partum depression, and post-traumatic stress disorder (PTSD) [5–7]. Up to 8.9% of women have reported a significant degree of chronic symptoms with a high disability after PDPH [8,9]. Optimal management of PDPH includes identifying patients who have had a difficult neuraxial block, providing adequate follow-up, identifying patients with PDPH, offering a therapeutic epidural blood patch as definitive treatment if needed, and monitoring for long term PDPH side effects.

PDPH definition, incidence, and diagnosis

Headache postpartum has an incidence of almost 40% [10,11] and may be due to many causes (Table 1). PDPH may occur after intentional or unintentional dural puncture (UDP, also called an epidural "wet tap") and is the most common postoperative complication of neuraxial anesthesia/analgesia, occurring in 0.4–1.5% of all parturients [12,13]. Alarmingly, 33% of dural punctures are seen after epidural catheter placement and up to 38% of parturients who experienced a PDPH postpartum may have never had a recognized dural tear/puncture [14].

A thorough history, physical examination, and laboratory tests, if needed, will guide diagnosis and management. The most used definition of PDPH comes from the International Headache Society (IHS), with the diagnosis dependent upon a headache developing within 5 days of the dural puncture.

Table 1
Post-partum headache differential diagnosis.

Cerebral arterial thrombosis
Cerebral venous thrombosis
Cortical vein thrombosis
Hypertensive encephalopathy or bleeding
Hypoglycemia
Intracranial hemorrhage
Lactation headache
Medications (e.g. magnesium)
Meningitis
Migraine headache
Nonspecific headache (e.g. stress)
Pituitary apoplexy
Pneumocephalus – immediate
Post Dural Puncture Headache
Posterior reversible encephalopathy syndrome (PRES)
Preeclampsia/eclampsia spectrum
Pseudo tumor cerebri
Ruptured aneurysm or malformation
Sinusitis
Stroke (ischemic or hemorrhagic)
Subarachnoid hemorrhage
Subdural hematoma
Temporal arteritis
Tension headache
Tumor
Withdrawal headache (e.g. caffeine)

Accompanying symptoms may include neck stiffness and cranial nerve symptoms of vision or auditory changes (Table 2) [15]. Long considered a hallmark of PDPH, the HA should be positional (i.e., significantly better supine than upright), although according to IHS, 5% of PDPHs may not exhibit a positional/postural component [16,17]. The HA location may be frontal, occipital, or posterior in the back of the neck, often with nausea, stiffness of the neck, tinnitus, or dizziness [18]. Cranial nerve symptoms occur in approximately 1–2.7/100,000 neuraxial anesthetics with the most common symptoms being blurry vision (sixth cranial nerve – CNVI, involving the lateral rectus muscle), and auditory changes (CN VIII involving the vestibulocochlear nerve, CN VII involving the facial nerve (CN VII), or via an endolymph-CSF (cerebrospinal fluid) connection) [10,11,18,19]. The headache most often starts within 48 h of a dural puncture and usually resolves within 2 weeks in an epidural UDP and within 2–3 days following spinal anesthesia with the use of a pencil-point spinal needle [15,17]. Epidural puncture or 'nicking' of the dura may not have been noticed in >30% of post-epidural PDPHs [17,20–22]. The incidence of PDPH occurs more commonly in individuals aged <40 years, women, pregnancy, increasing needle size, cutting edge needle bevel compared to blunt or 'pencil point' design, needle orientation, number of attempts, and history of a prior PDPH (Table 3), [11,23]. In the obstetric patient, the incidence of a PDPH after an epidural UDP ranges from 50 to 60% [12–14], and 0.8–6% following spinal anesthesia (depending on needle size and type) [12,24,25]. About 25% of childbearing age women have migraines and about half will have a migraine within the first month after birth [26]. In one study of postpartum headache before discharge, the most common causes were tension-type/migraine headache (47%), preeclampsia spectrum (24%), and PDPH (16%) [27]. Most studies show a rate of about 50–68% of Epidural blood patches (EBP) for patients with PDPH [13,25,28–30], with a second EBP rate of 8–20% [13,25,30].

PDPH pathophysiology

A dural puncture allows CSF to leak out of the central neuraxial space, leading to a decrease in intracranial CSF volume, low intracranial pressure, and a compensatory increase in intracranial blood volume [31]. The relatively lower CSF volume in the intrathecal sac allows for a relative 'sagging' in the upright position, with tension on the cranial nerves and blood vessels, leading to the postural nature of the headache/cranial nerve symptoms. The rare complication of intracranial bleeding was detected in 0.46% of obstetric patients with PDPH [30], presumably occurring from traction/tearing of the bridging veins. The symptoms of a postural headache may be from pulling (tension) on the cranial nerves (VII, IX), intracranial arteries, venous sinuses, or meninges [32]. Auditory changes such as muffled hearing may be due to connection from the endolymph to CSF and 'buzzing' in the ears may be due to tension or pressure on the CN VIII (eighth cranial nerve) [19]. An EPB is the treatment of choice for PDPH with cranial nerve symptoms and often provides immediate relief of symptoms [19,33,34].

When intracranial CSF volume decreases, the intracranial vessel dilates, and the blood volume increases [31]. The characteristic positional headache may be produced by activation of the trigeminovascular system by pain-sensitive blood vessels or the traction on spinal and cranial nerves. The physiologic changes in low intracranial pressure produce the classic radiologic findings of downward displacement of the brain, subdural fluid, distended venous system, pachymeningeal enhancement due to increased venous flow, and expansion of the pituitary gland [31].

Table 2
Common PDPH symptoms.

Cephalgia (worse upright)
Diplopia
Emesis
Hyperacusia
Nausea
Neck Stiffness
Photophobia
Tinnitus
Vertigo

PDPH = Post Dural Puncture Headache.

Table 3
PDPH-associated risk factors.

Anxiety
Depression
Increased depth to epidural space
Low BMI
Migraine headache
Needle bevel perpendicular to long axis of spine
Needle size
Needle type (i.e. cutting spinal needle)
Number of attempts
PDPH prior history
Pregnancy/multiparity
Women
Young age

PDPH = Post-Dural Puncture Headache.

PDPH time course and consequences

All patients regardless of their symptoms should receive post-neuraxial follow-up [7,35], especially for a known epidural UDP [28]. Most post-delivery follow-up occurs in the hospital 24–48 h after delivery, but symptoms may develop following a long period. Following spinal anesthesia, PDPH symptoms developed within 24 h in 65% and between 24 and 48 h in another 27% [18]. Patients with suspected PDPH should be seen and evaluated on time, within 24 h [17]. Up to 1.4% of patients may report symptoms after discharge, with 44% being HA [36]. Most PDPHs from a small gauge pencil-point spinal needle spontaneously resolve when the dural puncture self-heals within 2–3 days. The symptoms of a PDPH from a UDP occur over a longer period, typically 1–2 weeks, due to the larger (approximately 17 gauge) epidural needle size/dural tear and therefore takes longer for the dural puncture to heal. Rare complications are known to occur from low intracranial pressure from CSF leak including sagging and tearing of the bridging veins, resulting in intracranial subdural hematoma [30,37]. In the past, long-term consequences, except for a 4.3-fold relative increased risk of PDPH with subsequent neuraxial anesthesia were unknown [38]. Recent studies have shown significant intermediate or longer-term consequences associated with PDPH including increased risk of cerebral vein thrombosis (adjusted Odds Ratio, aOR = 11), subdural hematoma (aOR = 77), persistent headache (aOR = 6), backache one year later (aOR = 4), postpartum depression, PTSD, and decreased breastfeeding (Table 4) [7,8,37].

PDPH management and treatment

Proactive PDPH minimalization strategy

Since cutting edge design needles are associated with a higher incidence of PDPH, non-cutting 'pencil point' design spinal needles are recommended, preferably ≤25 gauge pencil-point spinal

Table 4
Intermediate and long-term consequences of PDPH.

Cerebral Vein Thrombosis
Impaired Breastfeeding
Persistent Backache
Persistent Headache
Post Traumatic Stress Disorder
Postpartum Depression
Subdural Hematoma

PDPH = Post Dural Puncture Headache.

needles, as per the Society for Obstetric Anesthesia and Perinatology (SOAP) Centers of Excellence [39]. If a difficult neuraxial placement is anticipated, a recent meta-analysis revealed a statistically significantly reduced incidence of complications including headaches, bloody taps, and paresthesias with the use of ultrasound for neuraxial placement [40–42].

Unintentional dural puncture (UDP) management

An unintentional dural puncture (UDP) with an epidural needle has generated some controversies over the best clinical approach. Some studies have suggested threading the epidural catheter intrathecally, thereby obstructing the hole and presumably decreasing efflux of CSF and subsequently the chance for a PDPH [11,28]. However, most studies utilizing an intrathecal epidural placed catheter have not shown the expected benefit of a significantly decreased PDPH rate to be true [14,28]. Furthermore, the uncertain benefit of a decreased incidence of PDPH is grossly outweighed by the real risks of inadvertent gaps in aseptic technique or administration of an epidural dose (concentration and volume) of local anesthetic via the intrathecal route resulting in a high or total spinal [14,28]. The most common recommended clinical approach is to withdraw the epidural needle after a UDP and reinsert the epidural catheter at an adjacent intervertebral lumbar level, being careful with dosing to make sure there is not an exaggerated intrathecal translocation of epidurally placed local anesthetic.

Conservative, symptomatic treatment options

Traditional treatments for PDPH fall into either conservative (symptomatic, or time-based) or the more definitive procedure-based physiologic treatments. When PDPH results from a smaller gauge pencil-point spinal needle, which is usually self-limited to 2–3 days, symptomatic treatment with temporizing analgesics and/or caffeine may be sufficient and definitive treatment with an EBP is not required. If the symptoms are debilitating (e.g., unable to sit up or take care of newborn after analgesics), an EBP should be performed. Note that more than one hole may have been created in the dura during attempted spinal anesthesia with multiple passes when advancing the spinal needle too far and pulling back to obtain CSF flow or multiple attempts at epidural analgesia. The latest data on increased long-term symptoms associated with PDPH suggest the need for a more aggressive approach to 'definitive' procedural treatment with EBP, but prospective randomized controlled trials on treatment and longer-term outcomes need to be performed. A prospective case-controlled study found an *almost* statistically significant long-term chronic backache adverse event in the treatment of a PDPH with an EBP [8].

Conservative or 'symptomatic' treatments may make tolerable the PDPH and its associated symptoms, allowing time for the primary physiologic problem (i.e., the dural hole) to heal and close (Table 5). Some classic symptomatic 'treatments' may not be efficacious (e.g., hydration) or practical (e.g., recumbent position), especially in parturients exhibiting severe PDPH symptoms. For symptomatic PDPH following an unintended epidural puncture, many clinicians will try a limited-time trial of analgesics (e.g., 1–2 days), and then perform an EBP if symptoms persist. Many practitioners prefer to try a period of a conservative measure before performing an EBP, as the success rate of an EBP is greater when performed more than 48 h after the dural puncture [17,43–45].

Prophylactic epidural blood patch

Prophylactic blood patches immediately after delivery do not significantly decrease the incidence of PDPH [46]. However, the same study documented that prophylactic blood patches shorten both the duration and severity of PDPH symptoms [46].

Therapeutic epidural blood patch

As previously mentioned, the success rate of the EBP is greater when performed more than 48 h after dural puncture [16,17,42–45]. The optimal EBP volume may be 15–20 ml, although the injected volume is often limited by patient symptoms during injection (e.g., extreme back pain) [35,44]. One

Table 5
PDPH-treatment therapies.

Conservative treatment (for first 24–48 h)
Abdominal binder
Bed rest
Rehydration
Pharmacological treatment options
Analgesics (NSAID's, aspirin, acetaminophen, oral opioids)
Caffeine sodium benzoate
Oral caffeine
Pharmacological treatment options with insufficient evidence
Adrenocorticotropic hormone (ACTH)
Desmopressin (DDAVP)
Dexamethasone, methylprednisolone
Gabapentinoids
Hydrocortisone
Mannitol
Methylergonovine
Neostigmine & atropine
Ondansetron
Other xanthine derivatives (aminophylline, theophylline)
Triptans
Definitive invasive treatment
Therapeutic epidural blood patch
Definitive invasive treatment with insufficient evidence
Acupuncture
Greater occipital nerve block
Intrathecal catheter placement after UDP
Prophylactic epidural administration (morphine, saline, dextran, hydroxyethyl starch, gelatin, and fibrin glue)
Prophylactic epidural blood patch
Prophylactic intrathecal morphine
Sphenoplatine ganglion block

PDPH = Post Dural Puncture Headache.

retrospective study in an institution that used an average blood volume of 27.3 ± 7.7 ml for EBP reported a need for a second EBP of only 2.6% [13]. In some non-obstetric anesthesia-related patients, EBP treatments may use ≥40 ml, especially in patients that do not respond initially, although these patients usually receive sedation [33]. In a study of 150 non-obstetric spontaneous intracranial hypotension patients, the use of >22.5 ml for EBP had a higher first initial EBP success rate (68% vs. 47%, P = 0.01) and reached an 80% response rate with a CSF collection of more than eight segments on MRI [47]. A second EBP may be indicated in up to 20% of patients [14,25,30]. Prior to proceeding with a rare third EBP, a CT of the head or equivalent to rule out intracranial pathology (e.g., cortical vein thrombosis, subdural hematoma, or other CNS pathology) should be performed. For patients refusing blood products that have left the body (e.g., Jehovah's witness), a continuous closed loop from a peripheral vein (e.g., antecubital) to the epidural needle can be constructed with a stopcock/syringe to help aspirate and inject into the epidural needle for EBP.

Alternative PDPH treatments

Alternative solutions for EBP that have case reports or small case series but may carry an unknown increased risk with unproven benefit include Dextran-40 [48], gelatin [48], hetastarch [49], or 'fibrin glue' [50]. Epidural normal saline infusion is useful for only symptomatic (not therapeutic/definitive) treatment due to epidural pressure improving intracranial pressure temporarily during the infusion [11,51]. Sphenopalatine ganglion block and more recently inhaled nebulized dexmedetomidine have also been described as decreasing pain from PDPH [52,53].

Radiographic and ultrasound imaging for definitive location of CSF leak

Patients who experience positional 'low intracranial pressure' headaches over several months as a result of a dural leak (sometimes associated with a connective tissue disorder) may require imaging (MRI or digital subtraction myelography) to find the exact location of the leak [34]. Farb et al. found that MRI combined with digital subtraction myelography could locate CSF leak in 87% of patients with Spontaneous Intracranial Hypotension (SIH) [54]. In non-obstetric patients, a success rate of up to 68% has been shown to occur with the use of fibrin 'glue' as the component of the epidural blood patch with or without the use of fluoroscopy [33,55,56]. A non-targeted (not directly injected at the site of the dural leak) EBP of a 10 ml mixture of autologous blood, fibrin glue, and contrast dye provided relief in 68% of patients with SIH, with radiologic spread occurring along the posterior surface of the dura [56]. MRI predictors of a 'good' EBP outcome were a pontomesencephalic angle <40° and location of the radiologic "iter" >2 mm below the incisura line ($P < 0.05$) [57,58]. If the fibrin glue fails, neurosurgical closure may be needed in severe cases [33]. Rebound high-pressure headache occurs in 27% of patients who receive treatment for SIH, were more likely to be younger, female and show signs of cerebral venous outflow restriction on magnetic resonance venography [33].

Recently, transcranial doppler measurement of the middle cerebral artery velocity has been used to predict those at increased risk for PDPH, with pre-dural puncture values of mean and maximum velocity significantly higher in those who developed PDPH [31]. A significant inverse correlation occurred between headache severity and pre-dural puncture Pulsatility Index. In a study of spinal anesthesia for cesarean, the baseline mean velocity >68.4 cm/s and 24-h Pulsatiltiy Index <0.75 were good predictors of PDPH with a sensitivity and specificity ≥94% for mean velocity and 100% for Pulsatility Index [59]. Prophylactic hydration with 1 L normal saline intravenous and 1.5 L oral fluids in the 24 prior to the procedure resulted in a decreased post-lumbar puncture headache from 37% to 15% ($P < 0.023$), with improved mean velocity and Pulsatility Index scores [60].

Backache

Low back pain during pregnancy and immediately postpartum has been found to be frequent in multiple studies, in the range of 40–50% [35,61]. Recent and prior studies have found an increase in long-term backache associated with PDPH [5,7–9]. Some sources of back pain may include neuraxial insertion skin puncture(s) or needle path(s), musculoskeletal discomfort from positioning or pushing herniated disc, and sacroiliac joint dysfunction [11,62]. Currently, there is no way to discern if the PDPH associated with chronic back pain identifies those at risk for increased sensitization to backache or has a more causative role in the pathophysiology of developing chronic back pain. In an international study of >1000 postpartum patients with PDPH, Gupta et al. found that those with more severe headaches were more likely to receive an EBP, with 19% requiring a second EBP [28]. Furthermore, after one week, most patients who received an EBP either had no HA or a mild HA, although backache and headache were more common (adjusted odds ratio of 4.14 at 18 months) in the group who needed an EBP [6,30].

The use of neuraxial anesthesia in subsequent pregnancies after a PDPH

The scientific literature supports the use of neuraxial techniques in patients with subsequent pregnancies, especially the use of an epidural catheter for labor analgesia. However, a patient with a history of a prior PDPH is up to 4 times more likely to develop a subsequent PDPH with dural puncture [38]. Avoidance of neuraxial anesthesia is not indicated, unless a specific medical indication contradicts neuraxial placement (e.g., coagulopathy, extensive spinal surgery with hardware).

PDPH proactive prevention

Emphasis on proactive PDPH prevention is equally important in lessening adverse outcomes.

The use of ultrasound before neuraxial placement may be an effective way to reduce complications for anticipated difficult neuraxial blocks. Recently published data in 2021 indicate a reduction in the odds ratios for PDPH, bloody tap, backache, and an increased first pass successes rate with the use of

neuraxial ultrasound before neuraxial placement [40–42]. Another strategy to reduce pre-procedural risk would be to employ transcranial doppler measurement of middle cerebral artery flow velocity screening for risk stratification [59].

PDPH follow-up

Because of the real possibility for long-term sequelae, all patients with a confirmed or suspected PDPH should receive PDPH education regarding if symptoms occur or worsen, to follow-up with a physician [35].

Summary and conclusion

All patients with a confirmed or suspected UDP or PDPH need a brief physical examination for the presence or absence of neurologic symptoms (e.g., cranial nerve function, motor reflexes). Patient follow-up should occur in the first 24–48 h after a UDP. In patients with mild PDPH symptoms within the first 24–48 h, conservative measures for symptomatic relief (e.g., non-opioid analgesics, opioids for severe breakthrough pain, recumbent position, and adequate hydration) are recommended. A therapeutic EBP should not be delayed in patients exhibiting severe PDPH symptoms, especially when affecting the mother–child interaction. Some patients may require a second therapeutic EBP with a classic clinical history for PDPH and a partial or temporary response to the first therapeutic EBP. In those parturients whose headache is not getting better or progressively getting worse, further neurological workup or neurological consultation including brain imaging is advised. Prior to a third therapeutic EBP, further investigation including a neurological consult needs to be considered.

Practice points

- Utilization of ultrasound before neuraxial placement for difficult patients may decrease PDPH risk.
- When symptomatic, all patients with a suspected PDPH need to be evaluated and diagnosed before treatment.
- Patients exhibiting mild symptoms can be managed conservatively whereas patients with severe symptoms should receive definitive EBP treatment.
- In patients with a persistent headache after EBP, other causes of headache must be considered.
- To avoid long term sequelae, patients with a PDPH should have appropriate short- and long-term follow-up.

Research agenda

- Does EBP prevent long term complications such as HA and back pain?
- Would alternative interventions (e.g., fibrin glue under fluoroscopy or even neurosurgical closure of the dural leak) be a better option for severe PDPH treatment?
- More research is needed to determine the optimal timing and treatment for conservative measures and timing of the therapeutic epidural blood patch.
- More research is needed to determine the number of EBPs that should be offered for effective PDPH treatment.
- Further research is needed to determine when further neurological workup is necessary or neurological consultation is warranted.
- Further research on the utility of transcranial doppler middle cerebral artery blood flow measurements for predicting patients at risk for PDPH is warranted.

Source of funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Declaration of competing interest

None.

Acknowledgments

None.

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