



NARRATIVE REVIEW

Prevention and Management of Post- Dura Puncture Headache (PDPH)

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Abstract

Background: Post-Dural puncture headache (PDPH) is the commonest complications during diagnostic, therapeutic or inadvertent lumbar puncture. It is unavoidable problem during dural puncture and what we can do is decreasing the incidence by taking all precautions and if it occurs, manages appropriately. Despite the existence of wide ranges of popular therapies, there is a continuous controversy about their effectiveness. Many of previously thought as preventive or therapeutic options are getting outdated and ineffective. This review aimed to provide clear knowledge to all anesthetist, surgeons and health care providers on the preventive and management methods of headache after accidental Dural puncture.

Methodology: MEDLINE, PubMed, Google Scholar and Cochrane Library search engines were used to filter the available evidences to draw recommendations and conclusions.

Keywords

Epidural blood patch, Headache, Pain management, Postdural puncture headache, PDPH, preventing of PDPH, pharmacological treatment for PDPH.

with cerebrospinal fluid (CSF) leakage through the puncture hole and is not accounted by any other cause. The headache is generally located in the frontal or occipital areas, or both, and presents with characteristic dull or throbbing that worsened in upright posture and better in supine [2].

Incidence

The incidence varies depending on the type and size of the needle, experience of the health personnel, age and sex of the patient. It was 66% in 1898 [3] and decrease to 11% in 1956, with the introduction of 22G and 24G needles [4]. It varies in different regions with diverse techniques different ages. In obstetric the incidence is 2 - 4.6 % in Middle East [5], 22.7% in Western Africa [6], 16.9% in Southeast Asia [7], 16.6% in North Europe [8] and 6% in North America [9,10].

In our country (Ethiopia) the incidence is not yet reported but the prevalence is quite higher compared with other literatures. A Study in Gondar hospital in 2015 reported that the overall prevalence of PDPH after SA was 38.8% [11] and another study done in Bahir Dar, Felege Hiwot Hospital in 2017 reported as 42.6 % [12].

Risk factors

Reported risk factors can be stated as: those related to the patient's history (history of PDPH or chronic headache, young age, female gender, lower BMI, nonsmoker, stress, tall height, lower SBP), those related to neuraxial technique (large-bore needles, cutting-tip needles, provider's experience, time of neuraxial procedure performed), obstetrical events (second stage

Background

Post-Dural puncture headache is one of the most common complications of diagnostic, therapeutic or inadvertent lumbar puncture and is a common cause of significant morbidity especially in the obstetric population. It increased hospitalization and morbidity for patients and stress for physicians [1].

The International Classification of Headache Disorders defines PDPH as a headache that occurs within 5 days of a lumbar puncture and is associated

pushing) and Dexamethasone therapy.

Many studies have showed that women have a 2-3 times higher risk for PDPH than men. The etiology behind these findings is not clear but it could be hormonal difference or pain sensitivity in female or any else. Meta-analysis supports this report [13]. The incidence is higher in young adults (20-30 years), lowers for older than 60 years and younger than 13 years. This could be due to lower CSF pressure both extreme ages. A systematic review of 18 trials reported that non pregnant females are two times more likely developing PDPH than male with OR =0.55 and 95% CI = 0.44-0.67 [13]. According to Kuntz K. et.al the incidence of PDPH is high in low body mass index (BMI) [14] while unrelated in some studies. Women who are obese or morbidly obese may have low incidence of PDPH because their increased intra-abdominal pressure may act as an abdominal binder helping to seal the defect.

Clinical Symptoms

PDPH presents as a dull throbbing pain with a frontal-occipital distribution. The cardinal feature is its postural nature with symptoms worsening in the upright position and relieved with decumbency. The headache may be associated with neck pain or stiffness, nausea, vomiting, tinnitus or photophobia, and in severe persistent cases, cranial nerve palsy or subdural hematomas. Usually patients describe it "a headache worsen at standing and improved in lying flat" [15].

Onset and duration

Symptoms can be seen after 12–48 hours and rarely more than 5 days following meningeal puncture. The natural history of PDPH written in most text book is resolve within 2 weeks but we are not sure. Vandam and Dripps follow patients up to 6 months after SA and they reported that 72% of PDPHA resolved within 7 days and 27% by 6 months. PDPH symptoms may lasting for months or years [16,17].

Generally in majority of cases headache resolve within two weeks but if left untreated it may leads to cranial nerve palsies, thrombosis and subdural hematomas. It may also predispose to chronic headache. It is known that PDPHA is a leading cause of lawsuits and this increases professional stress [15].

Diagnosis

Diagnosis is usually made in consultation with an Anesthetist and is based on history, with specific diagnostic criteria set by the Headache Classification Subcommittee of the HIS:

- Headache that worsens within 15 minutes of sitting and standing, and improves within 15 minutes after lying flat with at least one of the following:(Neck stiffness, Tinnitus, Hypacusia, Photophobia, Nausea, Dural puncture has been performed

- Headache develops within 5 days after dural puncture and mainly resolves either spontaneously within 2 weeks

It should be noted that even though majority of cases develop a positional headache that worsen at upright position, there are a minority of patients who develop atypical headache worse with recumbent position. Also there are studies indicating PDPH can occurs within 3 days after dural puncture and up to 29% of patients have headache as the only symptom and rarely the headache may last for months or even years [17,18].

Preventive Measures PDPH

Needle size and Needle design

Large spinal needles produce large dural perforations while smaller needles produce small dural perforations with lower incidence of headache. A recent study shows the incidence of PLPHA decreases with higher gauge Quincke needles as follows: 16 to 19 G, about 70%; 20 to 22 G, 20 to 40%; and 24 to 27 G, 5 to 12% [19]. The author of Cochrane review in 2017 reviewed 66 RCTs found out a traumatic tip resulted in a higher risk of PDPH compared to atraumatic tips, no difference with various sizes of large and small traumatic gauges and no significant differences with a higher gauge to a smaller gauge, in atraumatic needles. Use of smaller epidural needles (18- vs. 16-gauge) is associated with a lower incidence and severity of PDPH. Using 18G special Sprotte epidural needle results less PDPH than 17G Tuohy (55.5% vs. 100%) [20].

Direction of bevel

Parallel orientation separates the dural fibers rather than cuts them, less damage and facilitates dural hole closure on withdrawing [21]. There is Class III evidence in anesthesiology literature that indicate less incidence of PLPHA if the bevel is inserted parallel to the dural fibers. To date there are five observational studies that shows reduced incidence of PDPH after SA (by 50% or greater) if the bevel is parallel rather than perpendicular.

Regarding the direction of the bevel of a Tuohy needle, Norris, et al. [21] reported a decreased incidence of PDPH when the bevel entered the epidural space along the long axis of the spine and then was rotated 90 degrees before inserting the catheter compared to keeping a perpendicular approach.

Replacement of the stylet before withdrawing the needle:

Replacements of the stylet before withdrawing the needle decrease the incidence of PDPH when using a noncutting needle and unknown for Quincke needle. A randomized controlled study on 600 patients report shows that replacing stylet has low PDPH (5% with a p < 0.005) than patients without replacing (16%) [22]. The possible mechanism is a strand of arachnoid may enter

the needle with the CSF and when the needle is removed the strand may be threaded back through the dural defect and produce prolonged CSF leakage (evidence level 2). Whether reinserting the stylet following an LP with a Quincke needle would reduce the incidence of PDPH is not known.

Conservative measures

These therapies aim to decrease CSF loss through the dural hole and restore CSF with additional fluid intake and bed rest. Neither bed rest nor hyper hydration were found to be protective against PDPH in a systematic review and meta-analysis [23] (Evidence level one). Abdominal binders, previously used to increase epidural pressure and prevent CSF leakage, are impractical and have shown no benefit in the prevention of PDPH.

Pharmacological prophylaxis

Several prophylactic drugs have been studied, but their clinical effectiveness has not been established and various regimens used have been associated with adverse events. A review of drug therapy for preventing PDPH that including 10 RCTs reports that reduction in the incidence of PDPH was seen with epidurally administered morphine (RR=0.25), intravenous cosyntropin (RR 0.49), and intravenous aminophylline (RR 0.21 at 48 hours). But the benefit of each drug was only demonstrated in a single study and there is not sufficient evidence to support routine uses of these drugs [24]. The author of that review did not recommend the routine uses as large and multicenter RCTs are needed. Recent review on dexamethasone done in 2015 and 2017 shows prolong and postpone PDPH by blocking the inflammatory process at the puncture site. The authors of this review suggest that considering the use of Glucocorticoids e.g. dexamethasone is a risk factor for development of PDPH.

Intrathecal catheter placement

Theoretically leaving an intrathecal catheter in the dural puncture hole up to 24 h can prevent PDPH by initiate local inflammation, seal the hole, encourages hole closure and prevents CSF leakage. During labor this procedure allows continuous drug administration and negating the risk of repeated dural punctures [22]. Available systematic reviews indicated that intrathecal catheter placement does not significantly reduce the incidence of PDPH. However, it can reduce the overall severity of PDPH and the need for an epidural blood patch. Intrathecal catheterization has potential risks such as meningitis or abscess, arachnoiditis, and cauda equina syndrome [25-27].

Prophylactic blood patch

A prophylactic epidural blood patch involves the injection of autologous blood through the epidural catheter (usually 20 mL) before removal of the

catheter. The proposed mechanism is preventing CSF leak with clotted blood at the site, facilitating sealing of perforation. It should be done after full recovery of sensation (at least 5 h after the last dose of epidural anesthetic) to prevent the inhibition of coagulation by LA or accidental total spinal anesthesia. These ideas make sense to consider prophylactic epidural blood patch as preventive means of PDPH. However, recent systemic reviews have not conclusively supported the use of a prophylactic epidural blood patch for preventing PDPH. A systematic review and meta-analysis of 9 studies (4 for prophylactic and 5 for therapeutic) reported that routine prophylactic epidural blood patch is not recommended because there are too few trial participants to allow reliable conclusions [28]. In 2010, Apfel, et al. reviewed 10 studies (5 non-RCTs and 5 RCTs) and found that in non-RCTs, PEBP was associated with a significant reduction in PDPH with RR of 0.48 but pooled results of the other five RCT failed to show statistical significance with RR of 0.32 [25]. Another RCT investigated the effect of PEB showed a significant reduction in the incidence of PDPH [26]. Although a prophylactic epidural blood patch was effective for some studies, methodological limitations were identified in these studies such as problems with randomization, blindness, and small sample size, and therefore there is a class one recommendation of not to use routine prophylactic EBP to prevent PDPH.

Prophylactic epidural saline or colloid solution

It is believed that injecting saline into the epidural space may increase epidural pressure and decrease CSF loss or induce an inflammatory reaction and promoting closure of the dural perforation. Histological studies have not demonstrated an inflammatory response following epidural Dextran 40 administration. Thus, there are no studies that are able to demonstrate either a sustained rise in CSF pressure or accelerated closure of the dural perforation after the administration of epidural saline.

The use of intrathecal saline was investigated in 2001 by a non-randomized, non-blinded study, which reported that injecting 10 ml NS in to epidural space reduces incidence of PDPH and need for blood patch [29]. However, a systematic review and meta-analysis of epidural saline failed to demonstrate these effects [24].

Management of post dural puncture headache

The occurrence of PDPH resulted from ADP is completely unavoidable but we can reduce the incidence via various means. The aim of management of post-dural puncture headache is to: (i) replace the lost CSF; (ii) seal the puncture site; and (iii) control the cerebral vasodilatation. Not all patients will require hospital admission because PDPH is usually a self-limiting process. If left untreated, 75% resolve within the first week and 88% resolve by 6 weeks. The treatment ladder of PDPH includes conservative therapies, medications,

nerve block and if necessary an EBP as described by South Australian Perinatal Practice Guideline [30].

Psychological

Patients who develop post-dural puncture headache may reveal a wide range of emotional responses from misery and tears to anger and panic. It is important both from a clinical and medico-legal point of view. So discussion on the possibility of headache before a procedure is necessary. It is important to explain the reason for the headache, the expected time course, and the therapeutic options available.

Conservative

Conservative treatments for PDPH are aimed at preventing or stopping the patient's headache once dural puncture has occurred. Classically, these therapies include bed rest, aggressive hydration, and NSAIDs.

Even though effectiveness of oral acetaminophen (1000 mg) along with fluid is not known, it is suggested by many health professionals. A survey of North American practitioner management regimens for PDPH reported that medications such as NSAID and opioids were employed by 87% and 71% of respondents respectively even though their effectiveness is not well known [9].

Analgesia

Simple analgesics such as paracetamol and NSAIDs, in conjunction with anti-emetics, are the mainstay of PDPH management and have evidence to support their routine use in PDPH. Antiemetic combined with other analgesics were suggested for migraine headache, but whether such medication effective for PDPH is not elucidated

Bed rest and various body positions

There is no evidence that support bed rest reduce the incidence of post LP headache compared with immediate ambulation. Surprisingly evidences shows that bed rest can be associated with a higher incidence of PDPH in particular patient groups and meta-analysis failed to show that bed rest is better than immediate mobilization [31]. It may postpone the occurrence of the headache. Bed rest may increase risk of deep vein thrombosis and pulmonary embolism particularly during the puerperium period. If a patient develops a headache, they should be encouraged to lie in a comfortable position. There is no clinical evidence to support the maintenance of the supine position before or after the onset of the headache. Lying in the prone position increases intra-abdominal pressure, which in turn increase the CSF pressure but this position is not practical for many patients in the postoperative period.

A report of Systemic review by J. Wiley & Sons in 2013 that included 23 trials shows that rest after lumbar puncture should not be routinely recommended. Instead,

people should be allowed to move freely in accordance with their ability and medical recommendations. These authors also published an updated review in 2016 by including 24 trials and found the same result and concluded that conducting research on bed rest and PDPH would not identify additional benefits and further studies are unnecessary(24). In summary, at this time there is no evidence to support the common practice of recommending bed rest in the prevention of PDPH.

Fluids

Traditionally taught that hydration helps increase CSF production but here is no human study to support this claim, and in sheep, it has been shown that dehydration does not affect CSF production [32]. Furthermore, there is only one study reporting the effect of hydration (oral hydration) on PDPH and it showed that the headache is unaffected by the amount of hydration [33]. Dr Geiderman in 2002 reported that Oral fluids can be encouraged, but over hydration has not been shown to be of benefit. John Wiley & Sons also reported that there are no clear benefits or adverse side effects associated with additional oral fluid supplementation. People should be free to decide whether or not to increase fluid intake after lumbar puncture, unless there are medical reasons that recommend one or the other [22].

Generally there is no evidence that vigorous hydration has any therapeutic benefit, or that it encourages an increased production of cerebrospinal fluid. However, no patient with PDPH should be allowed to become dehydrated.

Pharmacological

Methylxanthines

A group of derivatives of xanthine, act on adenosine receptors none selectively antagonists and lead to vasoconstriction, which negate the compensatory cerebral vasodilation. They also activate sodium-potassium pump that are involved in the regulation of CSF production [34].

Caffeine

Caffeine is the most studied drug for PDPH treatment and data are highly heterogeneous as both IV and oral formulations at varying dosages and intervals were utilized during the investigations. Even the current available meta-analysis or RCTs are opposite in their conclusion.

Many practitioners recommend the use of intravenous caffeine for the treatment of PDPH, citing its cerebral vaso-constrictive properties. The author of Cochrane review in 2015 also supports the use of caffeine for PDPH management. A survey of North America Anesthesiologists shows that 58% of respondents' uses caffeine for treating PDPH while it is inapplicable in UK North America [9].

Halker, et al. review 7 studies (5 RCTs, one quasi-RCT (IV) and 1 open-label trial (IV)) in 2007 and reported that caffeine is ineffective in the treatment of PDPH [35]. As experimental studies shows PDPH occur after removal of 10%-15% of CSF volume [36] and therefore caffeine lacks a strong and compelling pharmacological basis as a treatment to prevent or relieve PDPH. As explained by him, some of the studies looking in the caffeine did find a degree of clinical effectiveness but was deemed to be methodologically flawed. Recent evidence done on maternity and obstetrics suggests that caffeine intake does not provide a clinically significant improvement and may in fact cause more problems, such as maternal insomnia (CNS stimulate effect) , neonatal irritability, seizures and has temporary effect (3-5.7 hrs) [37]. Generally there are unsolved controversies for the routine uses of caffeine.

A. Sumatriptan

Sumatriptan is a serotonin-receptor agonist and a cerebral vasoconstrictor. It is commonly used in treating migraines, showed promise in early case series studies on PDPH [38]. However, to date, RCTs examining its efficacy have yielded negative results [39,40] , a finding that is concordant with the conclusions from the Cochrane review.

B. Theophylline

Theophylline was found effective in treating PDPH symptom in case series and in observational studies and author of the studies suggested it as an easy, rapid, non-invasive treatment for PDPH [40]. A recent RCT study compare theophylline with sumatriptan showed that the duration and length of hospital stay were significantly shorter in theophylline. Even though there is few evidences supporting the usage of theophylline we are not recommend as a routine use until high-quality supportive evidence occur.

A. Gabapentin and pregabalin

Are groups of anticonvulsants drugs (has similar in structure to GABA) and their exact mechanism for treating PDPH is unclear. Some of their activity may modulate the presynaptic NMD receptors at the level of the spinal cord or inhibit the sympathetic pathway of pain. They are widely used for neuropathic pain. Both medications have been shown to be effective in reducing the severity of pain associated with PDPH in their individual studies [41].

In a randomized study comparing gabapentin with pregabalin, both medications significantly reduced the severity of PDPH, and pregabalin was found to be the more effective of the two medications because pregabalin has a higher affinity for alpha-2-delta receptors, and analgesic efficacy [42]. Even though there are no adequate literatures for the uses of these drugs, the results of existing data are satisfactory (evidence

level two).

B. Adrenocorticotrophic hormone (ACTH)

Synthetic ACTH was reported as treatment for headache in the 1990s. The postulated mechanisms are (1) interacting with opioid receptors in vitro and have morphine-like effect or (2) increase brain β -endorphins or (3) stimulating the adrenal cortex which responsible for anti-inflammatory and water retention so that they may increase CSF production [43]. Even though many case studies said it was effective, RCT study in 2004 showed that single IM ACTH was not effective as compared with placebo [44]. ACTH is still on investigation and there is not sufficient evidence to support its inclusion in routine PDPH management

Peripheral nerve blocks (PNBs)

Peripheral nerve blocks have been used for the acute and preventive treatment of various headache types. Their analgesic effect typically lasts beyond the duration of anesthesia providing some patients with pain relief for several weeks or even months probably due to an effect on central pain modulation [45].

Greater Occipital nerve blocks (GON)

GON is the main sensory nerve of the occipital region derived from fibers of C2 and C3. When a bilateral GONB is performed, interruption of afferent input to the dorsal horn occurs and relief pain for either due to hedach or other chronic pain syndromes.

IT can be performed with variable degrees of success using the landmark technique, nerve stimulator or ultrasound guidance. Other supportive measures like hydration, analgesics, convenient positioning and laxatives should be continued.

In a retrospective study done in 2016 on 16 parturient showed that mothers who were treated with bilateral GONBs found successes rate of 90% [46]. A 6 month prospective audit done in 2014 on 18 in a mixed obstetric and no obstetric population showed headache was resolved in 12 patients (67%) [47]. An RCT comparing BON using a nerve stimulator and conservative therapy on 50 patients found that complete pain relief in the block group [48]. A narrative study done in India that included 5 studies and published on Korean journal in 2018 concluded that this technique is minimally invasive, simple procedure can be considered for patients early, along with other supportive treatment, and an epidural blood patch can be avoided.

Generally there are many case reports, 2 prospective an audit lasted for 6 month and one double blinded studies that approve the success of occipital nerve blocks for treating PDPH

Sphenopalatine ganglion block (SPGB)

The sphenopalatine ganglion is located in the

pterygopalatine fossa that has both sympathetic and parasympathetic components [49]. It can be accessed through either a transcutaneous or a trans nasal approach. The emergency medicine literature suggests that sphenopalatine ganglion block should be the first-line treatment of headache after DP because it is less invasive with reasonable success. A sphenopalatine ganglion block is performed by placing a cotton-tipped swab that is soaked with lidocaine into then nostril. In 1 case series of 32 patients, 69% of the women did not require epidural blood patch. To date, there is one observation, 1RCT study and many case series reporting the use of sphenopalatine block. There is no any reported complication.

Epidural blood patch (EBP)

It is a procedure performed by injecting an autologous blood in to epidural space that collected under aseptic condition. EBP is still the gold standard therapy for moderate to severe PDPH. There is no practical guidelines that recommend time to start EBP but it should be considered when conservatives and medical therapies fails or when the symptoms gets severe (ie, pain score > 6 on a 1–10 scale).

The possible mechanism of action of the EBP could be:

1. Immediate & sustained tamponade with a rise in CSF pressure leads to inhibition of adenosine receptor, cerebral vasoconstriction and reduce the elevated cerebral blood flow
2. Mechanical effect at Dura hole and limiting ongoing CSF leak by initiating inflammation and coagulation

Early studies on the efficacy of EBP were overstated (up to 90%) probably due to inadequate patient follow up and inclusion of patients [50]. Current data suggest that permanent cure by a single blood patch can be expected in approximately 65% of the cases. Complete pain relief is sustained in 35% - 70% of the patients [51]. A second blood patch has the same rate of success.

Debating issues regarding EBP

Optimal volume of blood for EBP

Conceptually, the volume of blood used should be sufficient to form clot over and to produce epidural tamponade. Practically Volumes of 2-60mls of blood have been used but optimal volume is unknown. A recent survey of north American anesthesiologists reported that two-thirds of professionals (66.8%) uses between 16 and 20 ml(9) . A recent RCT done in 2017 compares three volumes (15, 20, and 30 ml of blood) and found a pain relief of 61%, 73%, and 67% in the 15mL, 20-mL and 30-mL groups, respectively. Based on these results the authors suggested that 20 mL could be the optimal blood volume for a therapeutic EBP [52] and

current recommendations suggest 10 to 20ml should be injected with evidence level of one b.

Optimal site and time

An MRI study of the EBP in 5 young patients (31-44 yrs) with 20 mL blood noted a spread of 4.6 ± 0.9 intervertebral spaces, averaging 3.5 levels above and 1 level below the site of injection [53]. Based on this and other observations, it can be recommended to perform the EBP “at or below” the meningeal puncture level. However, the influence of the level of placement and use of an epidural catheter on efficacy for EBP has never been clinically evaluated

Heath Professionals delays to perform EBP until further confirming the diagnosis and to allow an opportunity for spontaneous resolution. A 1996 survey of UK neurological departments found that only 8% would consider the EBP before 72 hours had passed following LP. A recent survey of UK maternity units reported that 71% would perform the EBP only “after the failure of conservative measures” [9].

Surgical intervention

On rare occasions surgical intervention maybe required for a dural repairs if significant headache persists and is refractory to non-surgical treatments. Evidence of a significant CSF leak on imaging may also be an indication for surgical intervention [37].

Conclusion

PDPH is non-avoidable problem and it increased risk of Venus stasis, patient suffering, hospitalization and health care cost and sometimes end up with chronic headache and other complications. The best way to decrease PDPH incidence is avoiding dural puncture with a large-bore needle. Parallel bevel direction for quieneke needle, replacement of stylet for non-cutting needle, and 90 degree rotation of epidural needle can decrease the incidence of PDPH. There is insufficient evidence for pharmacological prophylaxis. Strict bed rest and over hydration is ineffective for the treatment of PDPH. Even though EBP is most effective treatment modality, it is evasive, costly and has its own complication so considering nerve block or effective drugs like Gabapentin and pregabalin is supported by current evidences.

Acknowledgments

First of all we would like to thank Wollo University who create the opportunity of working together and facilitate all resource or materials. We also thankful for those authors who publish their work in different databases and peoples participated in those studies. Lastly we would thank those intelligent people who create available databases. We have no any conflict of interest with anyone else.

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