

Standardizing Management of Post-Dural Puncture Headache in Obstetric Patients: A Literature Review

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Abstract

Post-dural puncture headache continues to be a significant cause of morbidity in parturients. Despite being a common complication faced by many anesthesiologists, there is a lack of consensus regarding its management. Many still use traditionally taught treatments such as strict bed rest and aggressive hydration despite lack of evidence for their usage. Few are using newly tested treatments such as gabapentin and ACTH despite being proven effective in randomized controlled trials. Furthermore, when and how the epidural blood patch should be used is contentious between different practitioners. This review aims at answering what is the best strategy to manage post-dural puncture headache and proposes an evidence-based practice guideline.

Keywords

Post-Dural Puncture Headache, Epidural Blood Patch, Complication from Epidural Placement, Management of Dural Puncture

1. Introduction

Post-dural puncture headache classically presents as a postural headache that occurs after puncture of the dura. It has been over a century since we have known about post-dural puncture headache. It continues to be a significant cause of morbidity for patients and stress for physicians. However, there is still no consensus on a standard strategy for its management. Many physicians are left to their own device on deciding which treatment option is best. Furthermore, many of the treatment options taught during medical school and residency are outdated and ineffective. In the past two decades, there have been many new studies on the prevention and treatment of post-dural puncture headache such as the use of intrathecal catheter, epidural morphine, intravenous gabapentin and

ACTH, etc. As physicians, changing our practice to adapt to new evidence is pivotal, but we have a natural resistance to change. The purpose of this review is to look at the available evidence for the prevention and treatment of post-dural puncture headache and to formulate a practice guideline for this problem. The hope is that by having a guideline available for physicians to compare their practice to, it can help facilitate better evidence-based practices.

2. Pathophysiology

Knowledge of CSF leakage causing headache has been postulated since 1898 when Karl Bier correctly surmised this relationship based on his first-hand experience. The normal adult's total CSF volume is approximately 150 ml, half of which is within the cranial cavity and half in the spinal canal. CSF production occurs mainly in the choroid plexus and about 500 ml of CSF is produced daily as it gets reabsorbed. CSF pressure in the lumbar region varies greatly with position. In the horizontal position, the pressure is between 5 to 15 cm H₂O. When assuming the erect position, this pressure increases to over 40 cm H₂O [1].

The spinal dura mater is a tough membrane and the outer most layer of the meninges that surround the brain and the spinal cord. When the dura mater is perforated, CSF will leak through it until it is closed either by intervention or through healing [1]. Healing of the dura mater is thought to be facilitated by fibroblastic proliferation of surrounding tissue and blood clots [2].

The mechanism by which CSF loss leads to a headache remains unclear, but there are two possible explanations. First, loss of CSF pressure can cause traction on intracranial structures upon assuming the erect position, leading to the symptoms. Second, decrease in CSF volume in the cranium leads to a compensatory venodilation via the Monro-Kellie doctrine. The doctrine states that the sum of CSF volume, brain volume, and intracranial blood volume remains constant, thus a fall in CSF volume would lead to an increase in intracranial blood volume by way of venodilation, causing the headache [1] [3].

The incidence of post-dural puncture headache varies depending on the type and size of the needle used. A cutting needle would increase the rate compared to a pencil-point needle since it causes more damage to the fibers of the dura. As fibers of the dura are cut, they retract under tension, leaving behind a larger defect. Examples of cutting needles are Quinke and Tuohy needles. Examples of pencil-point needles are Sprotte, Whitacre, and Gertie Marx. Dural puncture with a 22G Quinke has a PDPH incidence of 36%, compared to a 22G Whitacre, in which the incidence is 0.6% - 4% [1] [4]-[7]. Since adopting the pencil point needle in obstetric anesthesia, the most common cause of severe headache now is accidental dural puncture with a Tuohy needle during epidural placement. In a large meta-analysis, Choi *et al.* showed that parturients have approximately a 1.5% risk of accidental dural puncture and of those, approximately 50% developed PDPH [8]. Other studies since then have showed that after dural puncture with the Tuohy needle, the incidence of PDPH can be greater than 70% [9] [10]. The higher incidence from the more recent studies is likely from an increase in our ability to diagnose PDPH.

3. Diagnosis of Post-Dural Puncture Headache

The post-dural puncture headache can usually be diagnosed with a history of dural puncture and a presentation of severe postural headache. The onset is usually within the first three days of the dural puncture (90% of patients) and 66% starts in the first 48 hours [1] [11] [12]. Characteristically, the headache is severe, usually distributed over the frontal and occipital areas, radiating to the neck and shoulders. The pain is exacerbated by head movements and assuming an upright position. It is relieved by lying down. Other symptoms that may be associated with the headache include nausea/vomiting, hearing loss, tinnitus, vertigo, dizziness, cranial nerve palsies, visual disturbances, arm pain and thoracic back pain [13]-[17]. Although unlikely, intracranial subdural hematomas from tears in the bridging veins, cerebral herniation, and death have been described as a result from dural puncture [18]-[20].

Usually, post-dural puncture headache is diagnosed based on the international headache society classification criteria (ICHD-II criteria). To meet criteria, the patient needs to have a headache within 15 minutes after sitting or standing and improves within 15 minutes of lying down. The patient would need at least one of the following symptoms in association with the headache: neck stiffness, tinnitus, hypacusia, photophobia, or nausea. The headache has to have developed within 5 days after a dural puncture. Finally, the headache should resolve spon-

taneously within 1 week or within 48 hours of receiving effective treatment of the spinal fluid leak (usually by epidural blood patch) [21]. However, these criteria alone are not sensitive enough to pick up many patients with post dural puncture headaches. A recent study widened these criteria to include patients with postural neck ache with or without headache along with symptoms such as dizziness, tinnitus, and muffled hearing and they also extended the period of symptoms from 5 to 14 days. With these widened criteria, the sensitivity for detecting post-dural puncture headache increased from 36% to 71% and the positive predicted value increased from 69% to 88% when compared to ICDH-II criteria [22].

Other causes for headache should be considered especially when the patient does not present with postural features. Up to 39% of parturients report symptoms of a headache unrelated to dural puncture following delivery [23]. Differential diagnosis includes pre-eclampsia, drugs withdrawal (*i.e.* caffeine), migraine, sinus headache, meningitis (viral, chemical, or bacterial), intracranial hemorrhage, cerebral infarction, intracranial tumor, pituitary apoplexy, cerebral sinus thrombosis, and non-specific headaches [1]. Some of these diagnosis may be life threatening, thus should be considered when the patient does not respond to treatment as expected.

4. Management of Post-Dural Puncture Headache

4.1. State of Current Practice

There continues to be a lack of consensus among anesthesiologists regarding the management of post-dural puncture headache [24]. In 2011, Baysinger *et al.* did a survey of anesthesiologists in North America regarding the management of post-dural puncture headache. The result showed that protocols are rare and management highly variable. Many anesthesiologists continue to use traditionally taught treatments including aggressive hydration, oral caffeine, NSAIDs, and bed rest despite lack of evidence supporting these therapies. In addition, most anesthesiologists also avoid new techniques that have showed promising result such as IV cosyntropin and neuraxial morphine [25]. Moreover, 80% of respondents reported abandoning conservative therapy and administering epidural blood within 24 hours of dural puncture despite evidence suggesting that epidural blood patch is more effective if performed after 24 to 48 hours [25]-[28]. Other surveys in North America as well as other continents show that this inconsistency in management exists all around the world [24] [29]-[33].

The thought behind using conservative therapy to treat PDPH is that the symptoms can be treated until the dural defect heals on its own. Many articles quote that >85% of PDPH will resolve on its own without treatment. The source of this statistic is from a study in the 1950's, in which 72% of post-dural puncture headache resolved spontaneously by 1 week, and 86% by 6 weeks. In this study, patients were getting spinal anesthesia utilizing 22 gauge and 24 gauge cutting needles [13]. With the use of pencil point needles and smaller size needles, significant post-dural puncture headache after spinal anesthesia today is now negligible. A more common cause of post-dural puncture headache in the practice of anesthesia now is accidental dural puncture during epidural placement using Tuohy needles. Tuohy needles are generally 16, 17 or 18 gauge, thus making a larger defect than the needles used in the quoted study. This means that waiting for spontaneous resolution is likely not as reliable as traditionally thought when treating this type of PDPH. In fact, most of these patients likely will need definitive treatment with a blood patch. One institution published their 10 years' experience with PDPH where >80% of their patients who developed headache after accidental dural puncture required blood patches [9].

4.2. Preventive Measures to Reduce Incidence of Post-Dural Puncture Headache

Over the years, physicians have tried many techniques to prevent accidental dural puncture and development of post-dural puncture headaches. In 2010, Apfel *et al.* published a quantitative review in the British Journal of Anaesthesia looking at strategies to prevent PDPH. Methods reviewed included epidural morphine, prophylactic epidural blood patch, intrathecal catheter, epidural saline, and intrathecal saline. This review found that epidural morphine use did significantly reduce the development of PDPH. The other methods either did not lead to significant reduction in PDPH when randomized controlled trials were analyzed or they did not have randomized controlled trial evidence available [34].

In 2013, a meta-analysis was published reviewing forty RCTs ($n = 11,536$ epidural placements) that investigated measures to prevent PDPH [35]. The different methods studied included combined spinal-epidural (CSE),

loss of resistance to air vs fluid, needle bevel orientation, different types of epidural needle, ultrasound guided insertion, prophylactic epidural blood patch, and continuous spinal anesthesia after a wet tap. In the meta-analysis, CSE, air vs fluid, ultrasound guidance, and continuous spinal after a wet tap did not make a significance difference in the incidence of post dural puncture headache. A separate meta-analysis study looking into continuous spinal after wet tap showed that although it does not reduce the incidence of PDPH, it does significantly reduce the need for an epidural blood patch [36]. Lateral orientation of the needle bevel (parallel to the vertebral column) during insertion was found to reduce the incidence of PDPH from 2.4% to 1.4% ($P < 0.03$) in one trial, but it was deemed to be of low quality in the meta-analysis [35] [37]. There were four randomized controlled trials looking into prophylactic blood patch. The prophylactic blood patch is performed by injecting 15 - 20 ml of blood through the epidural catheter before pulling it. Three of the four RCTs analyzed showed a statistical difference in PDPH rate, but the one that did not show a difference was methodologically superior since it used a sham procedure to eliminate the placebo effect [35] [38]-[41]. More recently, another RCT investigated the effect of prophylactic epidural blood patch was published in 2014, and it did show a significant reduction the incidence of PDPH. However, the control group in this trial also did not receive a sham procedure and thus it cannot fully account for the placebo effect [42].

The use of intrathecal saline was investigated in 2001 by a non-randomized, non-blinded study, which showed that injecting 10 ml normal saline through the epidural needle immediately after accidental puncture led to decreased incidence of PDPH and decreased need for blood patch [43]. Beside that study, there continues to be a lack of sufficient evidence to support the use of intrathecal saline in the setting of accidental dural puncture. Interestingly, an 18G special Sprotte epidural needle was invented to help reduce the incidence of PDPH. Using it did lead to a significant decrease in the development of PDPH compared to the 17G Tuohy (55.5% vs 100%), however, it also resulted in poorer loss of resistance, more failed block, and lower user satisfaction and thus cannot be recommended [44].

4.3. Conservative Therapies

Conservative treatments for PDPH are strategies short of performing an epidural blood patch aimed at preventing or stopping the patient's headache once dural puncture has occurred. Classically, these therapies include bed rest, aggressive hydration, caffeine, and NSAIDs. However, the evidences supporting these therapies are either lacking or highly equivocal. Carbaat *et al.* published a study in 1981 randomizing patients who received lumbar punctures to immediate mobilization versus 24 hours of bed rest showed no difference in the rate of PDPH [45]. Other studies since then on different populations have also showed no effect of bed rest of the rate of PDPH [46]-[48]. Of note, even though the recumbence position does not prevent PDPH, it can lessen the symptoms, and should be advised if symptoms are severe. With regards to keeping the patient hydrated, it is traditionally taught that it helps increase CSF production. There is no human study to support this claim, and in sheep, it has been shown that dehydration does not affect CSF production [49]. Furthermore, there is only one study looking into the effect of hydration (oral hydration) on PDPH and it shows that the headache is unaffected by the amount of hydration [50].

The question of whether caffeine is effective has been more studied than the effects of bed rest and hydration. A systemic review published in 2007 by Halker *et al.* devoted specifically to this question came to the conclusion that caffeine is ineffective in the treatment of PDPH [51]. As explained by Halker *et al.*, some of the studies looking in the caffeine did find a degree of clinical effectiveness [52] [53], but was deemed to be methodologically flawed [51]. A randomized, double-blinded, placebo-controlled trial by Esaoglu *et al.* comparing oral caffeine-paracetamol to placebo showed no significant difference on PDPH [54]. More recently, a randomized, double-blinded, placebo controlled trial by Ragab and Facharzt in 2014 comparing intravenous caffeine with placebo shows that IV caffeine can be effective in reducing the rate and severity of PDPH [55]. It may be that intravenous caffeine is effective while oral caffeine is not. Like many of the other treatments for PDPH, until more studies are done, we are left to our clinical judgments as to when and how caffeine should be used.

There are other conservative therapies being studied that have also showed promising results. A prospective, randomized, double-blinded, placebo-controlled trial in which epidural morphine was administered as two 3 mg dose 24 hours apart reduced the incidence of PDPH from 48% to 12% ($P = 0.014$) [56]. This result is very encouraging since epidural morphine is a therapy widely used to help with labor pain and has a good track record,

thus can be easily adopted to help prevent PDPH. ACTH is thought to work by increasing CSF production and in a prospective, randomized, double-blinded, placebo-controlled trial, a 1mg IV bolus dose given prophylactically after accidental dural puncture decreased the incidence of PDPH from 68.9% to 33.3% ($P = 0.001$) [57]. In a randomized, double-blinded trial comparing IV ACTH to IV caffeine for the treatment of post-dural puncture headache found no difference in pain score between the two groups [58]. IV dexamethasone may reduce the incidence of PDPH based on a single-blinded randomized, control trial [59]; but in a double-blinded, randomized, placebo controlled trial, IV dexamethasone had no effect on the incidence of PDPH [60]. Frovatriptan may be effective in preventing PDPH based on a non-randomized, non-placebo controlled pilot study [61].

For the reduction of pain severity in patients with PDPH, gabapentin and pregabalin are newer therapies being studied. Gabapentin and pregabalin are widely used medications for neuropathic pain with good track records. Both medications have been shown to be effective in reducing the severity of pain associated with PDPH in their individual studies [62]-[65]. 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 [66]. The typical dose of gabapentin used in these studies is 900 mg/day and pregabalin is 150 mg/day.

4.4. Epidural Blood Patch

It has been accepted for a long time that an epidural blood patch is the definitive treatment for PDPH [67]. The blood patch is an effective treatment in many cases, but there are still many questions surrounding it. In a single-blinded randomized controlled trial, the blood patch was significantly more effective than conservative treatment [68]. In a prospective study auditing 81 parturient with PDPH, 58 (72%) patients received at least one therapeutic blood patch [28]. Of the patients requiring blood patches, 28% required more than one due to the return of symptoms. Complete relief of headache was achieved in 50% of patients who got blood patches, 38% got partial relief, and 12% got no relief. The volume of blood used in this study varies between 7 to 25 ml and there was no significant association between the volume of blood used and the success rate. In addition, they found that the initial rate of resolution did not differ whether the blood patch was done within 48 hours of dural puncture or after 48 hours of dural puncture; however, those that received the blood patch within 48 hours had a much higher recurrence rate (49% vs 11%, $P < 0.001$) [28]. Another study at a different institution showed similar success rate and a similar percentage of patient requiring more than one blood patches [69]. Although success rate after epidural blood patch is high, patients may have recurrence of symptoms after discharge. In a study of 87 patients requiring epidural blood patch, 71% had complete resolution on discharge; but in a follow up survey (73% response rate), 57% of respondents had return of symptoms after being discharged home [70].

In patients with persistent PDPH, they should be followed up closely because intracranial subdural hematoma is a rare, but potentially fatal complication. Subdural hematoma is usually caused by tears in the bridging veins, which can be stressed by traction when CSF volume is reduced. Although rare, there have been many case reports of subdural hematoma following dural puncture [71]-[78]. For cases of persistent PDPH resistant to conventional epidural blood patches, considerations should be given to fluoroscopically guided epidural blood patch, CT guided epidural blood patch, and surgical dura repair [79]-[81].

5. Discussion

We are currently in a time when standardized medical care is becoming more widespread. Standardization of care improves evidence-based practice as well as allows better communication and data collection between institutions [82]. As we adjust to medicine being more science-based, we must find algorithms or guidelines for the management of different diseases and complications. These algorithms should be based on sound scientific evidence. Scientific evidence evolves over time, and so should our practice. With regards to post-dural puncture headache, many physicians still manage it based on what they were taught in the past and not based on the best available evidence. **Table 1** offers a guideline on how to manage post-dural puncture headache based on evidence available at this time. At our institution, an internal survey has shown that there is a wide variety in how we treat PDPH and is very similar to what was reported by Baysinger *et al.* [25] (unpublished data). We will start using the proposed guideline as shown in **Table 1** to guide our practice decisions. The proposed guideline here may not be the best way to manage PDPH since the evidence for many of these therapies are equivocal, and some therapies are just beginning to be investigated. When more evidence is available, this guideline is sub-

Table 1. Proposed guideline for management of dural puncture and PDPH. This guideline is based on up to date evidence described throughout this paper. Levels of evidence are divided as follow: (Ia) Evidence from meta-analysis of RCTs, (Ib) Evidence from at least one RCT, (IIa) Evidence from at least one well designed controlled trial which is not randomized, (IIb) Evidence from at least one well designed experimental trial, (III) Evidence from case, correlation, and comparative studies, (IV) Evidence from a panel of experts.

Diagnosis of PDPH	<ul style="list-style-type: none"> - Headache develops within 14 days after dural puncture [22]. - Patient has head or neck ache within 15 minutes of sitting/standing and is relieved within 15 minutes of lying down [22].
At time of accidental dural puncture	<ul style="list-style-type: none"> - Patient has at least one of the following symptoms in association with the headache: neck stiffness, tinnitus, hypacusia, photophobia, or nausea [22]. - Insertion of intrathecal catheter does not prevent PDPH, but does reduce the future need for epidural blood patch [34]-[36]. This is recommended if intrathecal catheters can be safely managed at your institution. (Ia) - If an epidural catheter is in place, two doses of 3 mg epidural morphine given 24 hours apart is recommended [34] [56]. (Ib)
Prevention of PDPH after accidental dural puncture	<ul style="list-style-type: none"> - Consider giving a dose of 1 mg IV ACTH [57] [58]. (Ib) - Consider giving a dose of 500 mg IV caffeine [51] [52] [55]. (Ib) - Routine prophylactic epidural blood patch cannot be recommended [34] [35] [38]-[42]. (Ib) - Epidural blood patch within 24 hours of dural puncture is NOT routinely recommended. It may be even better to wait at least 48 hours [28]. (IIb)
Symptomatic treatment of PDPH within 48 hours of dural puncture	<ul style="list-style-type: none"> - Treatment of symptoms with gabapentin 300 mg TID [62]-[64] or pregabalin 75 mg BID is recommended [65] [66]. (Ib) - The recumbent position may be recommended to reduce symptoms, but strict bed rest is not necessary [45]-[48]. (Ib) - Oral caffeine and aggressive hydration are NOT recommended [50] [51] [53] [54]. (Ib) - An epidural blood patch should be offered to those with significant symptoms after 48 hours of dural puncture [28] [67]-[70]. (Ib)
Treatment of PDPH after 48 hours post dural puncture	<ul style="list-style-type: none"> - There is no ideal volume of blood for individual patients. Inject up to 20 ml or until patient feels pressure from the injection [28]. (IIb) - A second blood patch should be offered if the first blood patch resulted in no relief or if symptoms return [28] [69]. (IIb) - A head CT should be considered if patient has refractory headache despite receiving blood patches, altered mental status, or focal neurological defect [71]-[78]. (III)
Treatment of PDPH refractory to conventional epidural blood patch	<ul style="list-style-type: none"> - Consider head CT to rule out other causes of headache [71]-[78]. (III) - Consider fluoroscopically guided and CT guided epidural blood patch [79] [80]. (III) - Consider neurosurgery consult for surgical dura repair [81]. (III)

jected to change. But in the present, this guideline offers an opportunity for physicians to standardize their care to the available evidence. The end goal of this is to ultimately improve patient outcomes.

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Abbreviations

ACTH: adrenocorticotrophic hormone
 CSF: cerebrospinal fluid
 PDPH: post-dural puncture headache
 NSAIDS: nonsteroidal anti-inflammatory drugs
 RCT: randomized controlled trial
 CSE: combined spinal-epidurals
 IV: intravenous