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Review paper

Post-dural puncture headache (PDPH) – current state-of-art

Paweł Radkowski[1,2], Maria Agnieszka Derkaczew[2], Michał Wichrowski[2], Aleksandra Szczęśniak[2], Marek Gowkielewicz[3,4]

[1] *Department of Anaesthesiology and Intensive Care, Regional Specialist Hospital in Olsztyn, Olsztyn, Poland*
[2] *Department of Anaesthesiology and Intensive Care, School of Medicine, Collegium Medicum, University of Warmia and Mazury in Olsztyn, Olsztyn, Poland*
[3] *Gynecology and Obstetrics Clinic, Regional Specialist Hospital in Olsztyn, Olsztyn, Poland*
[4] *Department of Department of Gynecology, Gynecological Endocrinology and Obstetrics, School of Medicine, Collegium Medicum, University of Warmia and Mazury in Olsztyn, Olsztyn, Poland*

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Abstract

Introduction: The post-dural puncture headache (PDPH) is one of the frequently mentioned outcomes of procedures involving spinal taps, spinal anesthesia, or inadvertent puncture of the dura during epidural anesthesia.

Aim: The aim of this review is to thoroughly investigate the PDPH problem in anesthesiologist' daily practice.

Material and methods: The work is based on the available literature concerning the topic of PDPH and the author's experience.

Results and discussion: PDPH presents as persistent pain along with potential accompanying symptoms. The PDPH entails a multifaceted process incorporating diverse neurobiological and neurophysiological elements. Various factors directly impact the occurrence rate of PDPH, including the gauge of the epidural anesthesia needle utilized, patient medical history, and numerous other variables. The treatment varies depending on the intensity of symptoms and how long they last. One of the novel treatment options is sphenopalatine ganglion blockade.

Conclusions: A comprehensive investigation of this matter should alert medical personnel to the significant issue of PDPH and help prevent its onset.

Corresponding author: Maria Agnieszka Derkaczew; Department of Anaesthesiology and Intensive Care, School of Medicine, Collegium Medicum University of Warmia and Mazury in Olsztyn, Żołnierska 18, 10-561 Olsztyn, Poland.
E-mail address: m.derkaczew@gmail.com

1. INTRODUCTION

Headache constitutes a prevalent health issue affecting a significant portion of the population worldwide. One type of headache that often impacts the quality of life of patients is post-dural puncture headache (PDPH). This type of headache can result from various factors, including medical procedures such as lumbar punctures or anesthesia during childbirth. Its characteristics, mechanisms of occurrence, and clinical consequences are of interest to many scientists and medical practitioners.[1]

PDPH is one of the most commonly cited consequences of procedures involving lumbar puncture, spinal anesthesia, or unintentional dural puncture during epidural anesthesia. In medical practice, this syndrome accompanies procedures used for diagnostic and therapeutic purposes, mainly after lumbar puncture for cerebrospinal fluid collection, epidural drug administration, intracranial pressure reduction, during obstetric anesthesia, or in cases of unintentional dural puncture. This specific type of headache is a key issue in the fields of anesthesiology, neurology, gynecology, orthopedics, and other medical disciplines related to the diagnosis and treatment of neurological disorders. From the perspective of anesthesiology, unintentional or accidental dural puncture (UDP) during attempts at epidural anesthesia is a well-known event that can cause PDPH. Understanding the pathomechanisms of this condition, its causes, and methods of prevention and treatment are crucial for improving the quality of medical care and minimizing the risk of its occurrence.[2,3]

2. AIM

PDPHs present a significant challenge to patient functioning and hospital departments, primarily gynecological and neurological units. The purpose of this review is to thoroughly investigate PDPH, analyze existing theories regarding its etiology, and present the latest developments in the diagnosis and treatment of this condition. This work aims to provide a comprehensive view of PDPH issues by delving into current scientific research and reviewing medical literature. In this article, we will outline the definition of PDPH, discuss its clinical symptoms, and focus on various theories regarding the mechanisms underlying this type of headache, covering both neuroanatomical and neurophysiological aspects. Subsequently, we will present available diagnostic methods, as well as current trends in the treatment of PDPHs.

3. MATERIAL AND METHODS

The work is based on the available literature and the author's experience. The purpose of this article is to present the state of the art on the topic of PDPH. The search was conducted on electronic databases such as Embase, PubMed, Google Scholar, Scopus, Web of Science, and Cochrane Library yielded relevant articles using valid keywords. The search terms such as 'spinal anesthesia,' 'anesthesiology,' 'anesthesiologic complications,' 'post-dural puncture headache,' 'unintentional dural puncture,' 'dural puncture,' 'lumbar puncture' and 'epidural anesthesia' were used. Articles meeting the criteria were then independently included in the research process. We have meticulously considered both recent publications and foundational principles of anesthesiology.

4. RESULTS AND DISCUSSION

4.1. Characteristics of PDPH and its occurrence

PDPH manifests as continuous pain. Symptoms typically worsen in an upright position and improve when lying down. Symptoms of PDPH usually appear within 24–48 h after dural puncture, but there have been described cases where headaches fulfilling the diagnostic criteria of PDPH occurred even 14 days after the procedure. The duration of symptoms in 70% of cases is approximately 7 days. Sometimes this issue persists for months. Possible concurrent symptoms with PDPH include neck pain, neck stiffness, tinnitus, hearing disturbances, photophobia, nausea, dizziness, visual disturbances, and diplopia.[4–6]

Due to the occurrence of alarming concurrent symptoms, the role of differential diagnosis of conditions in which the above symptoms may also occur is very important. These conditions include, among others: meningitis, encephalitis, vestibular nerve or Meniere's disease, subarachnoid hemorrhage, cerebral venous thrombosis, migraine, and tension-type headaches. The frequency of post-dural puncture headaches is estimated at 30%–40% in cases of cerebrospinal fluid collection and 20% in diagnostic punctures.[7]

4.2. The pathomechanism of PDPH

The pathomechanism of PDPH is a complex process involving various neurobiological and neurophysiological factors. Several theories exist regarding the mechanisms underlying this type of headache:

1. Cerebrospinal fluid (CSF) loss
   One of the main factors associated with PDPH is the loss of CSF, which occurs as a result of lumbar puncture or other medical procedures. CSF loss can lead to decreased intracranial pressure, which in turn affects the constriction of blood vessels within the meninges. This phenomenon may be associated with reduced blood circulation in the surrounding structures, leading to the activation of pain receptors.[8,9]
2. Meningeal inflammation
   A lumbar puncture can introduce bacteria into the subarachnoid space, which can subsequently cause inflammation of the meninges. Inflammation leads to the release of pro-inflammatory substances and pain mediators that stimulate pain receptors within the meninges.[10]
3. Disturbance of CSF balance
   Lumbar puncture disrupts the balance of CSF, which can affect mechanisms regulating intracranial pressure.

These changes may lead to stretching of blood vessels, which in turn may induce pain.[11,12]

4. Central nervous system (CNS) hypersensitization
   Lumbar puncture and associated processes can lead to hypersensitization of the CNS. This phenomenon can make neurons more sensitive to stimuli, contributing to the occurrence of pain.[8,13,14]

4.3. Factors influencing the occurrence of PDPH

Several factors directly influence the frequency of PDPH, including the performance of epidural anesthesia (EA). This is the most popular and frequently performed procedure for managing pain associated with natural childbirth vaginal delivery. It has many advantages, but it is also associated with the risk of complications. Among them is UDP, with a subsequent risk of headache (PDPH). The exact frequency of accidental punctures is difficult to estimate because many of them are not reported or even detected, as the reported frequency ranges from 0.4% to 6% of EA procedures. Dural puncture with an EA needle results in a very high probability (64%–88%) of developing PDPH, especially in the obstetric population. The frequency of PDPH varies depending on the size of the EA needle used – for a 16G Tuohy needle, it can be as high as 88% compared to 64% for an 18G Tuohy needle.

Combined spinal-EA (CSEA) – the essence of this type of anesthesia is a dural puncture and thus constitutes an essential risk factor for PDPH. It follows, therefore, that the size of the needle used and the technique of puncture (angle of needle placement and depth to which it is inserted) influence the risk of dural perforation and thus the occurrence of a headache. The use of larger needles causes CSF to flow more rapidly during puncture, which has consequences described in the above-mentioned (section 3 of the article) pathomechanisms. The volume of CSF obtained during puncture also affects the risk of PDPH – the more CSF is obtained, or the more leaks unintentionally, the greater the risk of PDPH. Other factors also influence the risk of developing post-dural puncture headache (PDPH), including:

1. Classic Quincke needles and atraumatic Sprotte or Whitacre needles (using smaller diameter needles reduces the frequency of PDPH).
2. The type and amount of local anesthetic used at the puncture site may affect the risk of PDPH. Administering too much local anesthetic to the CSF may increase intracranial pressure and contribute to the occurrence of PDPH.
3. The time the needle remains in the puncture site – leaving the needle in place for a long time after sampling or drug administration increases the risk of more CSF leakage, which in turn affects the lowering of intracranial pressure and the occurrence of PDPH.
4. Patient history – a patient with a history of PDPH (a patient who has previously experienced PDPH is at risk of recurrence), and the presence of migraine headaches in the patient's history.
5. Younger age of the patient (mainly 31–50 years), female sex, and low body mass index (BMI) also contribute to the risk factors for PDPH.[15]

Several factors do not directly affect the frequency of PDPH, including:

- rest / lack of rest;
- small volume of collected CSF;
- variability in CSF biochemical parameters (one study did not indicate a relationship between the macroscopic appearance of CSF and the frequency of PDPH).

There is little data on:

- the impact of the specialist's experience performing the procedure (one study found no impact);
- patient position during the procedure;
- presence of coexisting diseases in the medical history (one study found no impact).

Considering the factors influencing the occurrence of another headache after a puncture, it is worth mentioning a study by Rodriguez-Camacho et al. published in 2023. In this study, information on clinical and socio-demographic data of patients was collected, such as age, sex, BMI, previous lumbar punctures in the medical history, headache, vascular risk factors (hypertension, diabetes, dyslipidemia, hyperuricemia, smoking, alcoholism), connective tissue diseases. The reason for referral for lumbar puncture was also noted, as well as caffeine consumption before the procedure, the place of the procedure, proper or improper patient positioning, difficulty palpating intervertebral spaces before puncture, local anesthesia or lack thereof, and the size of the needle used for puncture (20 G or 22 G). Blood glucose levels were measured before the puncture. The specialist's subjective perception of the overall difficulty of the procedure was also assessed. These data were collected after lumbar puncture procedures under normal clinical conditions and without procedure modifications. Patients were monitored for 7–14 days after lumbar puncture using a telephone interview, during which they were asked about the onset of orthostatic headache, the day of headache onset after lumbar puncture, headache intensity on a visual analogue scale (VAS) scale from 1 to 10, presence of accompanying symptoms including nausea, vomiting, tinnitus, or neck stiffness, the treatment used, need to visit the Emergency Department, and duration of headache in days. Among the group of 22 patients who developed PDPH, 20 (90.1%) required oral analgesic medication, but none of them required specialized medical assistance. The most commonly used analgesic medications were paracetamol (12 patients) and NSAIDs (9 patients). Other medications used included metamizole (4 patients), caffeine, and codeine (1 patient).[16]

4.4. Prevention of PDPH

Accurate identification of UDP during EA plays a crucial role. In most cases, diagnosis is straightforward, evidenced by the free flow of CSF through the epidural needle or CSF suction after catheter insertion. However, dural puncture may go unrecognized in up to 11%–33% of cases. Some sources suggest that in equivocal cases after catheter insertion, an attempt should be made to aspirate CSF, and the aspirated fluid should be tested using strip analysis or a glucometer to verify glucose and protein levels.[17,18]

Given the high incidence of PDPH after UDP, especially in the obstetric population, efforts should focus on improving methods for identifying accidental dural puncture, as it contributes to frequent PDPH occurrence in mothers and prolongs their hospital stay. It may also affect the quality of maternal care for the newborn. Recognizing UDP is important for optimizing post-UDP management methods to reduce the risk of PDPH.[15,19]

In the event of a UDP during EA, it is preferred to attempt a repeat neuraxial anesthesia, as this ensures good procedural quality. The use of intrathecal catheters following UDP is gaining popularity; however, there are no specific international recommendations regarding their use. Consequently, there are discrepancies in clinical practice regarding patient management after accidental dural puncture during EA. Attention is drawn to the need for proper management due to the potential occurrence of numerous other complications besides PDPH, including total spinal block, high block, hypotension, fetal distress, and compromise of fetal well-being. Intrathecal catheters must be used judiciously, following a risk-benefit analysis for the patient, strictly adhering to principles of aseptic and antiseptic technique, meticulous medical documentation, cautious drug administration, and clear communication with patients and medical staff.[15]

Preventing UDP itself plays a role in preventing PDPH. Analyzing the causes of UDP should aim to avoid as many instances of UDP as possible, thereby reducing the percentage of patients with PDPH. Unfortunately, the risk factors for UDP are not clear. Apart from the experience of the anesthesiologist performing neuraxial anesthesia, no other factors for UDP have been identified. The association between UDP and maternal obesity, advanced age, or lateral positioning, whether sitting or not, is not clear. A recent retrospective study involving 46,668 EA showed that women with greater cervical dilation at the time of EA placement are more susceptible to UDP due to the advancement of labor, which is characterized by increasingly painful contractions, significantly complicating the cooperation between the anesthesiologist and the patient, who finds it difficult to remain still.[8,20]

An additional risk of UDP is the laboring woman's demand for immediate pain relief and lack of understanding regarding the careful preparation required for a procedure that cannot be rushed. Such an atmosphere unnecessarily burdens the anesthesiologist performing neuraxial anesthesia. Another study indicated that repeated attempts at neuraxial anesthesia are a risk factor for UDP, and these attempts are more common when there are difficulties in finding the appropriate spinal interspace for puncture. Factors associated with difficulty in needle placement during EA include difficulty in palpating the intervertebral space, spinal deformity, stiffness, and the inability to flex the back. Obesity is a leading factor contributing to difficulties in performing EA due to the inability to accurately identify anatomical points through palpation. In summary, apart from the anesthesiologist's experience and patient cooperation, there are no other identifiable risk factors. In the case of an inexperienced anesthesiologist, early assistance in cases of difficult EA or involving an experienced anesthesiologist in cases of patients with greater cervical dilation, suggesting that they may not be able to lie or sit still during EA or are uncooperative, is crucial to reduce the risk of UDP, and thus PDPH.[15]

CSEA allows for rapid onset of analgesia due to the spinal component, with the additional option of using an epidural catheter to prolong analgesia by continuous drug infusion during labor. It is also applicable in cesarean section (CS) or for postoperative pain control. This method is gaining popularity in obstetrics, especially since the introduction of the technique of introducing the spinal needle through the epidural needle, which has reduced the need for more than one puncture and thus decreased the risk of complications. Furthermore, the use of new atraumatic needles with a pencil-point tip (they primarily spread the fibers of the dura mater rather than cutting them, hence the newly created hole in the dura allowing CSF leakage is smaller and heals more easily) is associated with a significant reduction in the risk of developing PDPH.[21,22]

In preventing the occurrence of PDPH, it is important to inform patients about the most common consequences of the procedure, whether accidental or intentional puncture and to react appropriately if these occur to prevent their exacerbation over time. In addition to this, to prevent the most common consequence of puncture, which is PDPH, appropriate hydration before and after the procedure is recommended, including oral fluid intake, avoiding alcoholic beverages, and patient remaining in a lying position.[23]

4.5. Treatment of PDPH

The treatment depends on the severity of symptoms and their duration. The most common methods of treating PDPH:

- epidural blood patch (EBP) – preferred treatment, invasive method, effective in up to 90% of patients within 48–72 hours
- flat bed rest
- sufficient sleep and rest
- fluid therapy
- use of analgesic medications (commonly used drugs include paracetamol, NSAIDs, opioids)
- adjunctive treatment with caffeine, theophylline, or 5-HT1 serotonin receptor agonists
- sealing the puncture site with a patch
- invasive treatment methods such as epidural administration of opioids or fluids.[23–26]

It is suspected that the sphenopalatine ganglion may sometimes be responsible for headache symptoms. In 1 clinical study, this was evaluated in the context of treating headaches after lumbar puncture during spinal anesthesia. The study assessed the effectiveness of nasal spray and gauze soaked with lidocaine. Patients in the study were divided into two groups. Participants in the first group received 2 doses of 10% lidocaine spray to both nostrils, followed by gauze soaked in normal saline solution. Individuals in the

second group received 2 doses of saline spray followed by gauze soaked in 2% lidocaine. Patients were assessed before the procedure and at 0.5 h, 1 h, 2 h, 24 h, 48 h, and 72 h after the procedure for pain relief. The VAS was used for this purpose. Hemodynamic parameters and adverse effects were also recorded. At each stage of measurement, the mean VAS score for pain significantly differed between the two groups of patients. Furthermore, the VAS score was significantly lower in the first group up to the 2nd hour. No significant adverse effects related to the interventions were observed in either group. This leads to the conclusion that 10% lidocaine spray administered nasally is more effective in treating PDPH after spinal anesthesia, especially within the first 2 h after administration, and does not cause noticeable adverse effects. Both techniques of sphenopalatine ganglion blockade provide effective relief for headache symptoms after lumbar puncture, without causing any significant side effects, but the technique of spraying with 10% lidocaine appears to be better, especially in the early period.[28]

5. CONCLUSIONS

1. A thorough examination of this issue should draw the attention of medical staff to the enormous problem of PDPH.
2. It should be noted that PDPH poses a challenge for both patients and medical personnel, making continuous knowledge expansion in this area crucial.
3. Understanding the exact pathomechanism of PDPH formation, the ability to differentiate PDPH from other medical conditions correctly to avoid overlooking life-threatening complications, and familiarization with innovative treatment and prevention methods for PDPH all play a significant role.
4. By preventing the occurrence of PDPH, we can improve the quality of life for patients affected by this condition, shorten their hospital stay, and thereby provide space for other patients in need of hospitalization.

Conflict of interest
The authors declare no conflict of interest.

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Ethics
Ethical committee approval and informed consent were not applicable.

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