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Treating Post-Dural Puncture Headaches: Sphenopalatine Block, Cosyntropin And Epidural Blood Patch

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Abstract

Post-dural puncture headache (PDPH) is a severe and debilitating complication that can occur following neuraxial anesthesia. Obstetric patients are at an increased risk for this complication due to their gender, young age, and widespread use of neuraxial anesthesia. A hallmark sign of PDPH is a postural headache that improves when lying down and worsens when sitting or standing. It requires prompt diagnosis and treatment due to its incapacitating effects. The gold-standard treatment for PDPH is an epidural blood patch (EBP). However, this is an invasive procedure with multiple contraindications and the potential for severe complications. Noninvasive, more conservative therapies such as sphenopalatine ganglion block (SPGB) and intravenous (IV) cosyntropin have shown to provide significant relief with PDPH and its associated symptoms. This paper will review the current literature on the management and treatment of PDPH with EBP, SPGB, and IV cosyntropin therapies.

Treating Post-Dural Puncture Headaches:

Sphenopalatine Block, Cosyntropin and Epidural Blood Patch

Neuraxial anesthesia is the most common method of pain relief during labor and delivery and helps keep the parturient and fetus safe. In 2017, there were 3,855,500 births in the United States, and of those births, 2,858,322 women had an epidural or spinal anesthesia during labor (Center for Disease Control, 2018). From this information, it can be concluded that approximately 74.1% of laboring women receive neuraxial anesthesia for pain management during labor and delivery.

The most common and debilitating complication of neuraxial anesthesia is a post-dural puncture headache (PDPH) that occurs after dural puncture. A PDPH is a postural headache that is caused by a decrease in cerebrospinal fluid (CSF) within the intrathecal space. While the exact mechanism is unknown, it is most commonly thought that the brain loses its cushion, normally provided by the CSF, resulting in a downward pull on intracranial pain-sensitive structures and causes a headache that is relieved when supine (Kwak, 2017).

Obstetric patients are more at risk of developing a PDPH because of their gender, young age, and increased use of neuraxial anesthesia (Sachs & Smiley, 2014). According to Kwak (2017), dural puncture occurred 1.5% of the time during epidural placement, and more than half of these patients develop PDPH. Specifically, more than 50% of women experience PDPH following dural puncture with 16-18-gauge epidural needles (Russell et al., 2019). Even in experienced hands, the risk of accidental dural puncture with an epidural needle is approximately 0.50%. However, in many teaching hospitals the risk is higher at 1 to 4% (Baysinger, Bucklin & Gambling, 2016).

Epidural blood patch (EBP) is effective and is considered the gold-standard treatment for a PDPH. However, it is an invasive procedure with contraindications and the potential for complications (Kwak, 2017). Alternatively, conservative and non-invasive treatments have been gaining popularity. Sphenopalatine ganglion block (SPGB) and IV cosyntropin are two of the many conservative and non-invasive options available that significantly reduce PDPH symptoms. A systematic review of current literature will further explore this topic and answer the following question: Are sphenopalatine ganglion block or IV cosyntropin as effective as an epidural blood patch in treating post-dural puncture headaches in the obstetric population.

Methods

A systematic literature review was completed using the University of New England's Library databases (i.e. CINAHL, PubMed and the Cochrane Library) and textbooks from the MSNA program. While searching the databases, several limitations were placed to obtain the most recent and relevant information within the last five, and up to ten years. Keywords searched included the following: post-dural puncture headache, epidural blood patch, sphenopalatine ganglion block, cosyntropin, obstetric complications, anesthesia, neuraxial, epidural.

The Subarachnoid and Epidural Space

The spinal cord is a cylinder-shaped structure, extending from the foramen magnum to lumbar level one (L1) in the adult. The cord terminates at the conus medullaris. A collection of nerve roots, known as the cauda equina, extend from L1 to sacral level five (S5). The spinal cord and cranium are surrounded by three layers called the meninges. These layers, from outer to inner, are known as the dura mater, the arachnoid mater, and the pia mater. The dura mater is the outermost layer and it is a thick and tough fibrous membrane that protects the spinal cord. The

subarachnoid space or intrathecal space lies between the arachnoid and pia mater. This is where CSF is found (Nagelhout & Elisha, 2018).

CSF provides cushion to the spinal cord and protects it from shock injuries. It is also the medium for medications during spinal anesthesia. As shown in Figure 1, CSF flows through the ventricular system and enters the subarachnoid space at the foramen of Magendie and the foramen of Luschka (Nagelhout & Elisha, 2018). It can be seen that CSF surrounds the medulla and brainstem, and any decrease in its volume can cause problems. This will be discussed in greater detail.

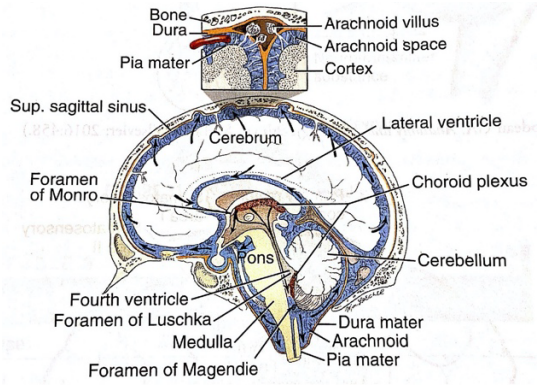

Figure 1. CSF Flow Through the Ventricular System and Brainstem. Adapted from J.J. Nagelhout, and S. Elisha. (2018). *Nurse Anesthesia.* (6th Edition). St. Louis, MO: Elsevier. pp 648.

The epidural space is a potential space within the vertebral canal and lies outside the dural sac. See Figure 2. It mostly contains epidural veins, fat and nerve roots. The distance from the skin to the epidural space or dura, is typically 4-6 centimeters (cm). This distance can vary depending on vertebral level and patients' weight. As the epidural needle is advanced midline, it passes through the skin, subcutaneous tissue, supraspinous ligament, interspinous ligament and ligamentum flavum before entering the epidural space. See Figure 2. The ligamentum flavum is the strongest posterior ligament and helps to maintain an upright posture. After the needle passes

through the ligamentum flavum, loss of resistance is felt within the epidural space. If CSF is present, the needle punctured the dura (Nagelhout & Elisha, 2018).

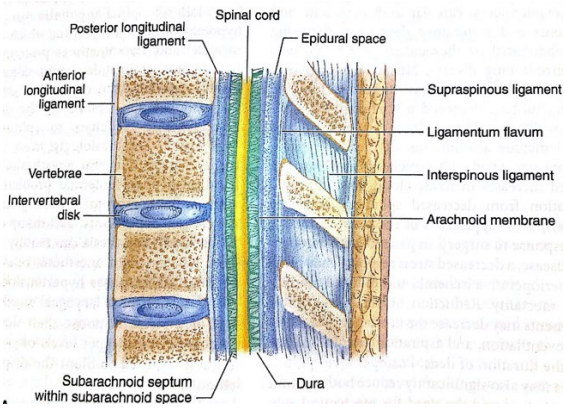

Figure 2. The Vertebral Column and Posterior Spinal Ligaments. Adapted from J.F. Butterworth, D.C. Mackey, and J.D. Wasnick. (2013). *Morgan & Mikhail's Clinical Anesthesiology*. (5th Edition). McGraw Hill Education. pp 940.

The anatomy of the vertebral column can present anesthesia providers with challenges, especially in a parturient. When placing an epidural, it is important to stay midline with the needle. Epidural veins are most prominent lateral to the epidural space and become engorged during pregnancy and with obesity. This increases the potential for accidental injury or cannulation to these vessels. Also, a temporary lordosis of the lumbar spine may occur during pregnancy. Changes to the normal curvature of the spine can challenge the anesthesia provider during neuraxial anesthesia placement (Nagelhout & Elisha, 2018).

Pathophysiology of PDPH

In 1899, Dr. August Bier first described PDPH after developing a postural headache 24 hours after receiving spinal anesthesia himself. The severity kept him in bed for nine days. He suggested this condition might be the result of a CSF leak (Kwak, 2017). An intruding needle creates a large hole in the dura, resulting in CSF leakage and a decrease of CSF within the intrathecal space. MRI studies on patients with PDPH have shown decreased CSF volume,

sagging of intracranial structures, and meningeal enhancement due to vasodilation of vessels secondary to intracranial hypotension (Sachs & Smiley, 2014).

Despite MRI evidence, the exact mechanism of the headache in this condition is unknown. However, several theories have been proposed. The most common theory assumes a headache in the upright position originates from a loss of the cushioning effect normally provided by the CSF, allowing the brain to sag within the skull (Kwak, 2017). The medulla and brainstem drop into the foramen magnum, stretch the meninges and pull on the tentorium. The downward pull on pain-sensitive structures is further irritated by movement and an upright position causes a characteristic headache. Normally, there is approximately a total volume of 150 milliliters (mL) of CSF in the adult (Nagelhout & Elisha, 2018). Orthostatic headaches can occur when roughly 10% or 15 mLs of the estimated total CSF volume is lost (Bezov, et al., 2010).

A second mechanism is based on the Monro-Kellie hypothesis, which states that the sum of brain tissue, CSF, and intracranial blood remains constant. A decrease in one compartment must cause an increase in one or two other compartments. When there is a decrease in CSF, the body responds by increasing intracranial blood volume. This response is mediated through compensatory cerebral vasodilation. This theory suggests that PDPH will be relieved by restoration of CSF volume but also that cerebral vasoconstrictors will provide symptomatic relief (Baysinger et al., 2016).

Clinical Symptoms and Diagnosis

PDPH can be severe and debilitating, preventing ambulation and time spent between mother and baby postpartum. It extends hospitalization and increases health care costs. Prompt diagnosis and treatment are necessary to limit and treat symptoms associated with PDPH. Multiple studies have shown that PDPH can result in cranial nerve palsy, chronic headache,

reversible cerebral vasoconstriction syndrome, subdural hematoma, intracerebral bleeding, cerebral venous sinus thrombosis, or cerebral aneurysm rupture (Sachs & Smiley, 2014).

The classic presentation of PDPH is a dull and throbbing pain with a bifrontal-occipital distribution associated with changes in posture. Typically, it is worse when sitting or standing and improves when lying down (Kwak, 2017). Diagnosis criteria includes a headache that develops within five days of dural puncture and resolves spontaneously within one to two weeks (Olesen et al., 2018) or up to 48 hours after an epidural blood patch (Kwak, 2017). It can be also be accompanied by neck stiffness and/or hearing symptoms (International Headache Society, 2018). It is important to note that up to 5% of patients may present with an atypical headache that has no postural component (Russell et al., 2019).

Up to one third of PDPHs occur following an unrecognized dural puncture (Russel et al., 2019). Other symptoms that can occur in more than half of patients include nausea, tinnitus, vertigo, and photophobia (Sachs & Smiley, 2014). Recent studies found that PDPH occurs within three days after dural puncture, and up to 29% of patients' only symptom is a headache (Kwak, 2017).

Differential Diagnosis

Improper diagnosis and treatment of PDPH can potentially lead to adverse neurological consequences in parturient patients. PDPH diagnosis should be questioned if a postural component is not present, and if fever, leukocytosis, and neurological deficit are present. This may be a sign of meningitis, cerebral thrombosis, and intracranial hemorrhage and should prompt additional testing. Pneumocephalus, hypertensive encephalopathy, severe preeclampsia,

and functional headaches such as migraines must also be ruled out as causes (Omole & Ogunbanjo, 2015).

Spinal and epidural hematomas occur when there is trauma to an epidural vein that causes bleeding and consequently compresses neural tissue. This compression restricts spinal cord perfusion and can result in many neurological symptoms that include sharp back and leg pain with motor weakness and/or sphincter dysfunction. Infectious complications of neuraxial anesthesia include meningitis, arachnoiditis and epidural abscesses. Meningitis and arachnoiditis symptoms include back pain, fever and/or other neurological symptoms. Epidural abscesses are also characterized by fever and back pain but may lead to progressively worsening neurological symptoms. These may include nerve root pain, radicular pain, motor deficits, sensory deficits, sphincter dysfunction, paraplegia and paralysis (Butterworth, Mackey, & Wasnick, 2013).

Other headaches that are common and can be associated with an increase incidence during pregnancy include migraines and tension headaches. Migraines are often pulsating focal headaches with vision changes and nausea. Tension headaches can be described as band-like with neck and shoulder pain. Both migraines and tension headaches last several hours to days. Other potential causes that must be ruled out with imaging include hemorrhage, stroke, and tumors (Russell et al., 2019). It is important to thoroughly assess parturient and postpartum patients presenting with symptoms that are not typically associated with PDPH and diagnose promptly.

Risk Factors for PDPH

Depending on the source, the incidence of a PDPH is anywhere from 0.2% to 70% (Kent & Mehaffey, 2016; Nagelhout & Elisha, 2018). The occurrence of this adverse complication of neuraxial anesthesia is highly dependent on associated risk factors. Anesthesia providers must

take all precautions to decrease risk factors associated with PDPHs. Modifiable and nonmodifiable risk factors are discussed below.

Nonmodifiable risk factors.

Age and gender. Studies show that young adults are at a higher risk for developing PDPH compared to the elderly (14% vs. 7%) (Omole & Ogunbanjo, 2015). PDPH risk is three to five times higher in 20 to 30-year-olds than those over 60 years. After the age of 40, PDPH incidence begins to decrease, and over the age of 60, it is considered rare (Bezov et al., 2010). As age increases, the dura is thought to be less elastic (Omole & Ogunbanjo, 2015). The dura is made up of dense longitudinal fibers that surround and protect the spinal cord. As one ages, these fibers become more fluid and are able return to their normal position after a needle is removed, preventing CSF leakage. Unlike younger women, with increased elasticity, these fibers are thought to be stiffer and maintain the defect in the fibers when the needle is removed (Amorium & Valenca, 2007).

Women are two times more likely to develop a PDPH when compared to men. Studies show that women in their 30's have three times higher incidence in developing PDPH then men from the same age group (Bezov et al., 2010). Young, pregnant women with a low BMI constitute the highest risk group (Sachs & Smiley, 2014).

Pregnancy. Pregnant women are more likely to develop PDPH when compared to age-matched nonpregnant women. This may be due to increased estrogen levels that influence the tone of cerebral vessels and may increase vascular distension in response to CSF hypotension (Kwak, 2017). It has also been suggested that it is not pregnancy but vaginal delivery that leads to an increased incidence in PDPH. It is thought that pushing efforts during second stage labor can increase the size of the dural hole and increase CSF loss (Baysinger et al., 2016). However,

Kwak (2017) mentions two retrospective studies reporting conflicting evidence on second-stage labor leading to increased severity of PDPH or the need for an EBP.

Previous PDPH and chronic headache. A prior history of a PDPH is a risk factor for the recurrence of a PDPH. Bezov et al. (2010) mentions two studies that find patients who have a history of PDPH developed it again, when compared to patients who developed one for the first time. Also, patients with a chronic headache history one week before a procedure had a 70% incidence of PDPH when compared to a non-headache group of 30%.

Modifiable risk factors.

Needle size and shape. Research shows that the larger the dural puncture, the higher the incidence of PDPH. Therefore, the size and type of needle are essential factors for decreasing the risk of this condition (Kwak, 2017). Cutting needles (Quinke) are five times more likely to have an increased loss of CSF when compared to a pencil point needle (Whitacre, Sprotte) of the same gauge. Also, a large 22-gauge needle is associated with a six-time increase in CSF leak and PDPH when compared to a 25-gauge needle (Sachs & Smiley, 2014).

Orientation of needle bevel. Studies show that introducing the bevel of the needle longitudinal to the meningeal fibers decreases CSF leakage and meningeal disruption (Sachs & Smiley, 2014). This allows the fibers to return to their position when the needle is removed (Omole & Ogunbanjo, 2015). One study mentioned in Sachs et al. (2014), states that the development of PDPH after a dural puncture is three times higher when the needle bevel is perpendicular to the spinal column compared to parallel. Non-cutting and small-bore needles have a reduced risk of PDPH and bevel orientation may be less important when using these needles (Omole & Ogunbanjo, 2015).

Morbid obesity. Multiple studies suggest that the incidence of PDPH is decreased in morbidly obese parturient patients. This is thought to be due to a lower pressure gradient from the intrathecal space to the epidural space, reducing the loss of CSF. Kwak (2017) states that the incidence of PDPH in patients with a BMI greater than 31.5 kg/m^2 was lower than that in those with a BMI less than 31.5 kg/m^2 (39% versus 56%, P = 0.0004). However, BMI did not affect the severity of PDPH or the need for an EBP (Kwak, 2017).

Treatment Options

Epidural Blood Patch

Physiology.

EBP is the definitive treatment for PDPHs. It is associated with a greater than 90-95% cure rate and is most effective when performed within 48 hours after dural puncture (Kokki, Sjovall, Keinanen, & Kokki, 2013; Sachs & Smiley, 2014). Although invasive, it works by forming a clot that seals the dural puncture, increasing CSF pressure and relieving meningeal tension (Kokki et al., 2013). MRI studies have shown that EBP blood extends three to nine spinal levels and adheres to the thecal sac. This results in clot formation at the meningeal puncture site for more than 18 hours. Also, the initial hematoma constricts the dural sac and nerve roots for up to three hours. This immediate compression temporarily restores normal intrathecal and intracerebral pressures and can explain the sudden relief patients experience (Sachs & Smiley, 2014).

Procedure.

The patient's back and intravenous sites are prepped and draped, and a sterile field is established. The first provider identifies the epidural space by either loss-of-resistance or hanging-drop technique. Usually, the insertion site is at or below the level of the dural puncture.

This is chosen because blood has shown to spread cephalad in the epidural space. The second provider obtains approximately 20 mL of autologous venous blood, and it is injected through the epidural needle into the epidural space. Injection continues until the patient feels pressure in the back, buttocks, or legs. Typically, this occurs at 12-15 mL of blood. The patient should remain supine for one-half hour to one hour before ambulating. PDPH relief is often immediate, and if no relief is obtained, a second EBP can be attempted after 24-hours (Nagelhout & Elisha, 2018).

Prophylactic EBP administered through an epidural catheter placed after a dural puncture has been shown to decrease the incidence of PDPH from 30-70%. However, other studies have shown that prophylactic EBP does not prevent a headache but may decrease its duration. Since many patients with a dural puncture do not develop a PDPH, a prophylactic EBP may expose women to unnecessary complications (Baysinger et al., 2016). These complications include common transient back pain and rare infection or neurological deficits (Kwak, 2017).

Side effects and contraindications.

Potential complications of an EBP may include direct spinal cord injury, dural puncture, epidural abscess or hematoma, vascular injection, infection at site of injection, meningitis, arachnoiditis, cauda equina syndrome, and unintended subarachnoid injection (Nagelhout & Elisha, 2018; Russell et al., 2019). Also, severe back pain, bradycardia, neurologic deterioration, postpartum seizures, and cranial nerve paralysis have also been reported. Contraindications of an EBP include: increased ICP, coagulopathies, possible CNS or systemic infections, local infections at the site of an EBP, malignancies, or inability to access the epidural space (Hanling et al., 2016).

Literature review.

A Cochrane review performed by Boonmak & Bookmak (2013) assessed the potential benefits and complications of an EBP in both the prevention and treatment of a PDPH. This systematic review included nine studies with 379 patients. It was found that prophylactic EBP improved a PDPH when compared to no treatment (OR (odds ratio) 0.11, 95% CI 0.02 to 0.65 one study), conservative treatment (OR 0.06, 95% CI 0.03 to 0.14, two studies), and epidural saline patch (OR 0.16, 95% CI 0.04 to 0.55, one study). However, prophylactic EBP did not result in less relief from PDPH when compared to a control group (OR 0.04, 95% CI 0.00 to 0.39, one study). Backache was the most common side effect associated with EBP. The authors do not recommend prophylactic EBP over other treatments due to the small number of participants in the studies. However, therapeutic EBP indicated an advantage over conservative treatment. This is all based on limited resources available.

In a study by Stein, Cohen, Mohiuddin, Drombrovsky & Lowenwirt (2014), a randomized control trial was performed to evaluate whether prophylactic or therapeutic EBP is beneficial for patients with dural puncture during epidural placement for labor analgesia or c-section. Eligible parturients were randomized to prophylactic or therapeutic EBP group. Patients assigned to the prophylactic EBP received 15-20 mL of autologous blood through the epidural catheter at least five hours following the last epidural local anesthetic dose. Patients were kept supine for one hour, and then the catheter was removed. If patients in the therapeutic EBP group developed a headache, they were initially managed with intravenous caffeine, saline patch, patient-controlled epidural analgesia, aminophylline, paracetamol, or oxycodone. If the headache persisted, patients were offered a therapeutic EBP, and 15-20 mL of autologous blood was administered into the epidural space and the patient was kept supine for one hour.

A total of 116 patients were randomized to either receive prophylactic EBP or therapeutic EBP. The occurrence of headache in the prophylactic EBP group was significantly less than the therapeutic EBP group. Eleven of the 60 (18.3%) patients in the prophylactic group developed a PDPH when compared with 39 of 49 patients in the therapeutic EBP group (P = <0.0001). An EBP was administered in 36 (73.4%) of the patients in the therapeutic EBP group. Patients requiring a second blood patch did not differ significantly between the two groups (10% vs. 11.1%). This randomized control trial by Stein et al. (2014) concluded that prophylactic EBP is an effective treatment to decrease the development of PDPH in obstetric patients.

Booth, Pan, Thomas, Harris, & D'Angelo (2017) retrospectively reviewed their obstetric database to estimate the incidence of an EBP associated with different anesthetic techniques and define the optimal volume of blood to administer during an EBP. A retrospective 15-year chart review of all EBPs at a University Medical School in the United States was performed. Patients who developed a PHPH were offered an EBP when symptoms were severe or had cranial nerve involvement.

Booth et al. (2017) reviewed 466 EBPs that were performed on 394 parturient patients. They found that 32% of patients who experienced a dural puncture with an epidural needle required an EBP. This compared to 0.19% of patients who received neuraxial anesthesia with an epidural needle and no documented dural puncture. All parturient patients who received an EBP experienced PDPH relief. However, 17% required two EBPs and 1.5% required three EBPs. The average +/- SD volume of autologous blood administered was 20.5 +/- 5.4 mLs and only 35 patients (8.9%) required 30 mLs.

This study by Booth et al. (2017) concluded that increasing EBP blood volumes up to 30 mLs did not decrease the need for a repeat EBP. The optimal amount of blood to administer

during EBP treatment remains unknown. However, the authors recommend administering blood until the patient experiences pain, or up to 30 mLs. This study's result for mean average blood administration is supported by a randomized control trial mentioned in this study. Due to the retrospective chart review nature of this study, the authors were unable to assess subjective variables such as duration of pain relief, the incidence of PDPH reporting, or severity of back pain on injection. Also, patients who suffered from a PDPH were only reported if symptoms were severe enough for an EBP to be offered.

Another retrospective study by Kokki et al. (2013) performed a chart review from two hospital databases analyzing the use, effectiveness, and timing of EBP in parturients over 13 years. A total of 129 patients received 151 EBPs. Among the 129 parturients, patients either received spinal anesthesia (n=49), epidural anesthesia (n=47), or combined spinal-epidural anesthesia (n=33).

Kokki et al. (2013) found that the first EBP had an 89% success rate with permanent relief in 76% of the patients. Furthermore, the first EBP provided permanent relief of PDPH symptoms for 86% of 78 patients who received an EBP after 48 hours, 65% of 37 patients who received an EBP between 24 and 48 hours, and 50% of 14 patients who received an EBP within the first 24 hours after dural puncture ($P = 0.003$). A second EBP was offered to 22 patients who did not experience permanent relief (n = 5) or who experienced recurrent symptoms (n= 17). All patients had complete resolution of all symptoms.

This study concluded that an EBP performed 48 hours after a dural puncture is effective in patients with PDPH symptoms. They also found that initial relief was experienced in 89% of patients, but symptoms reoccurred in 15%. The effectiveness of an EBP in this study was improved when administered later and in patients without severe symptoms. Stein et al. (2014)

also found that prophylactic EBP significantly decreased the development of PDPH in obstetric patients. However, Boonmak & Boonmak (2013) do not recommend prophylactic EBP due to limited studies and minimal study participants. Although Kokki et al. (2013), collected data from two hospitals, the sample size was small for the outcomes in this study. Due to conflicting studies, more research is required on the timing of EBP treatment.

So et al., (2016) performed a retrospective study to compare the effectiveness and number of EBPs for spontaneous and iatrogenic orthostatic headaches. This study was conducted at a university hospital inpatient and outpatient setting. Patients were separated into two groups according to the cause of orthostatic hypotension: spontaneous (Group S) and iatrogenic (Group I). Participants who received myelograms were also separated into two groups: multiple cerebral fluid (CSF) leakages and no multiple leakages.

A total of 133 patients received 162 EBPs. Group I consisted of 99 patients and 90.9% of the patients experienced complete recovery of symptoms following one single treatment. Group S consisted of 34 patients and 44.1% required repeated procedures. More EBPs were administered in Group S when compared to Group I ($P = 0.007$). A total of 23 patients were evaluated by myelography. They found that twelve patients had multiple CSF leakages and these patients required a higher number of EBPs when compared to patients without multiple CSF leakages ($P = 0.023$). So et al. (2016) concluded that most patients with iatrogenic orthostatic headache only required one EBP, even though most did not receive a myelogram. Patients who have spontaneous orthostatic headache or multiple CSF leakages were more likely to receive a repeat EBP.

Sphenopalatine Ganglion Block

Anatomy.

The sphenopalatine ganglion (SPG) is a triangular, cone-shaped ganglion located on the medial wall in the pterygopalatine fossa (Robbins et al., 2016). The sphenopalatine ganglion is an extracranial neural structure that is located in the pterygopalatine fossa. It contains both sympathetic and parasympathetic components as well as somatic sensory roots (Kent & Mehaffey, 2016). It is suspended from the maxillary nerve and leaves via the nasopalatine nerve, greater palatine nerve, lesser palatine nerve, lateral nasal branches, the pharyngeal branch of the maxillary nerve and orbital branches. When the SPG is activated, acetylcholine, vasoactive peptides, and nitric oxide are released from dural blood vessels. This causes inflammation and activation of trigeminal nociceptors and contributes to pain and triggers a headache (Robbins et al., 2016).

Physiology.

After a dural puncture, CSF volume decreases, and intracranial volume is restored through cerebral vasodilation. This vasodilation is mediated by parasympathetic activity synapsing in the SPG and is thought to be responsible for a PDPH (Nair & Rayani, 2017). The sphenopalatine ganglion block (SPGB) works by blocking parasympathetic flow to cerebral vasculature and decreasing cerebral vasodilation (Russell et al., 2019). This allows cerebral vessels to return to normal diameter and relieve the headache (Kent & Mehaffey, 2016).

Procedure.

In 1908, Dr. Sluder was the first to utilize the SPGB for the treatment of headaches (Robbins et al., 2016). The SPGB continues to be an effective treatment for migraines, cluster headaches, and trigeminal neuralgia and can be performed through transcutaneous, transoral, or

transnasal approaches (Kent & Mehaffey, 2016). There are several ways to administer a SPGB. Most commonly, the patient is supine with the neck extended. An applicator with a cotton swab is soaked with 2-4% lidocaine and inserted parallel to the floor of the nose until resistance is met. This location is the posterior pharyngeal wall superior to the middle turbinate. The applicator stays in place for 5-10 minutes and then removed and repeated in the other nostril. The applicator sits on the tissue membranes that surround the SPG (Nair & Rayani, 2017). There are various amounts of drugs, concentrations of local anesthetics, and different applicators used for the SPGB (Robbins et al., 2016).

The Tx360 is a new device designed for SPGB application. As shown in Figure 3, the Tx360 device is positioned in the anterior nasopharynx with the catheter retracted. The device is aimed slightly medial and inferior. The attached syringe is advanced from within the device into an open space of the nasopharynx. The syringe is turned laterally and positions the catheter opening at the location of the SPGB. The plunger is then pushed to deliver the medication through the catheter. The medication gets delivered lateral and superior to the sphenopalatine. These steps are repeated to treat bilateral sphenopalatine (Schaffer et al., 2015). See Figure 3.

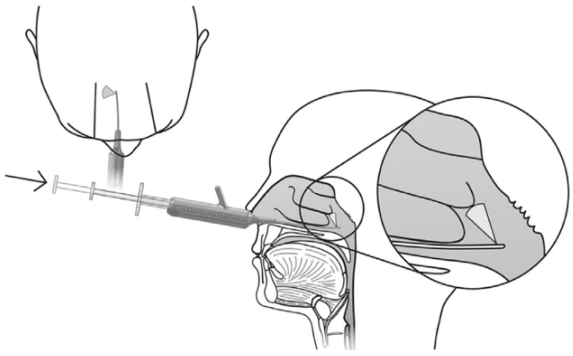

Figure 3. Sphenopalatine Ganglion Block with the Tx360 Device. Adapted from "Noninvasive Sphenopalatine Ganglion Block for Acute Headache in the Emergency Department: A Randomized Placebo-controlled Trial, by J. Schaffer, B, Hunter, K. Ball, and C. Weaver, 2015, *Annals of Emergency Medicine*, 65 *(5).* doi 10.1016/j.annemergmed.2014.12.012

Side effects and contraindications.

Side effects may vary depending on the device used, and patients may experience mild discomfort during the procedure. The medication may lead to an unpleasant taste and numbness in the back of the throat. Other side effects can include low blood pressure, nausea, and epistaxis (Robbins et al., 2016).

Literature review.

In the study by Schaffer, Hunter, Ball, & Weaver (2015), a randomized, double-blind, placebo-controlled study was performed to evaluate the effect of the sphenopalatine ganglion block (SPGB) for the treatment of an acute frontal headache in patients presenting to the emergency department. A total of 93 patients with a frontal-based crescendo-onset headache were randomized to receive either 0.5% bupivacaine or normal saline solution. Emergency department physicians administered bupivacaine or normal saline (0.3 ml per side) transnasally to the bilateral posterior nasopharynx using the Tx360 device (See Figure 3). Pain and nausea were assessed at 0, 5, and 15 minutes, and 24 hours. Rescue treatment for headache and nausea was available after 15 minutes.

Schaffer et al. (2015) found no difference between the two groups at 15 minutes. A 50% reduction in pain was achieved in 48.8% of people in the bupivacaine group compared to 41.3% of people in the normal saline group (risk difference 7.5%, 95% CI -13% to 27.1%). However, at 24 hours the authors found more patients in the bupivacaine group to be headache free (risk difference 24.7%, 95% CI 2.6% to 43.6%) and nausea-free (risk difference 16.9%, 95% CI 0.8% to 32.5%) when compared to the normal saline group. It was concluded that patients with an acute anterior headache, a SPGB with bupivacaine did not result in an increase in achieving greater than 50% reduction in headache severity at 15 minutes when compared to saline solution.

Cohen et al. (2018) performed a 17-year retrospective chart review comparing the efficacy of SPGB to EBP for the treatment of PDPH after a dural puncture in postpartum patients. A total of 81 patients were included in this review and received either a SPGB (n = 42) or an EBP (n= 39) for their PDPH treatment. Patients in the SPGB group were positioned supine and received 0.5 to 1.5 mLs of 4% lidocaine via a cotton-tip syringe applicator and kept in place for 15 minutes. An EBP was performed to normal standards in the EBP group.

Cohen et al. (2018) found that more patients experienced PDPH relief 30 minutes after SPGB treatment than after EBP treatment (38.5% vs. 20.5%, P = 0.0003). It was also found that more patients received headache relief one hour after SPGB treatment than after EBP treatment (71.4% vs. 30.8%, P = 0.0004). Additionally, there was no significant difference between the number of patients who received PDPH relief 24 hours, 48 hours, and one week after treatment. SPGB patients reported no treatment complications. However, patients in the EBP group reported the following complications: backache radiating to their lower extremities (7.7%), vasovagal reaction with autologous blood injection (2.6%), and temporary hearing loss (2.6%). No patients reported permanent complications from either treatment. All patients recovered from these complications within one week.

Channabasappa, Manjunath, Bommalingappa, Ramachandra, & Banuprakash (2017) performed a case study of a 42-year old female undergoing a total abdominal hysterectomy under combined spinal-epidural anesthesia. On postoperative day four the patient complained of a bifrontal postural headache and PDPH was suspected. The patient was initially treated with intravenous hydration, oral caffeine, NSAIDs and bedrest. The headache did not resolve and on postoperative day six a SPGB was performed with 0.5% ropivacaine. Only one SPGB was

performed and the patient experienced instant pain relief without reoccurrence. The patient was discharged home 24 hours later.

Kent & Mehaffey (2016) performed a small case series to determine if SPGB is an effective alternative treatment for PDPH. This case series consisted of three obstetric patients who received transnasal SPGB using a cotton-tipped applicator with 2% viscous lidocaine. The authors found that all three patients had significant headache relief following the SPGB and did not require an EBP.

Intravenous Cosyntropin

Physiology.

Cosyntropin is a synthetic equivalent of adrenocorticotropic hormone (ACTH) that stimulates the adrenal cortex to release aldosterone. The release of aldosterone leads to sodium and water retention, therefore, increasing blood volume and arterial blood pressure (Nagelhout & Elisha, 2018). Also, there may be an increase in the production of CSF through the active transport of sodium ions. It is thought that the expansion of blood volume and increase in CSF may lead to dural edema and promote closure of the dural tear. There is also an increase in beta-endorphin that may reduce pain perception (Hanling et al., 2016).

Contraindications.

Administration of cosyntropin should be cautioned in patients with hypertension or diabetes mellitus (Hakim, 2010). Contraindications to cosyntropin administration include hypersensitivity to the medication, acute psychosis, untreated infections, peptic ulcer disease, refractory heart failure, Cushing's syndrome, treatment of primary adrenocortical insufficiency and adrenogenital syndrome (Hanling et al., 2016).

Literature review.

A Cochrane review by Ona, Osoria, & Cosp (2015), assessed the effectiveness and safety of drugs for treating PDPH in adults and children. The authors reviewed data from 13 randomized control trials that evaluated a total of eight drugs. The studies mentioned in this review showed no significant difference when cosyntropin was compared to intravenous caffeine. They concluded that there was a lack of conclusive evidence for cosyntropin due to the limited number of studies and small sample sizes.

In a study by Hakim (2010), a randomized control study was performed to evaluate the effect of cosyntropin administration after a dural puncture on the incidence of PDPH and the need for a therapeutic EBP. Also studied was the impact on the severity of PDPH and the need for a repeat EBP. The patient population consisted of 90 parturients who had epidural analgesia for normal vaginal delivery and who suffered a dural puncture. Thirty minutes after delivery, the epidural catheter was removed, and patients were randomly assigned to one of two groups. Group 1 (treatment group) received a single intravenous injection of cosyntropin in a dose of 1 mg. Group 2 (control group) received an equal volume of IV normal saline. Patients were admitted to the hospital for 48 hours, and headache symptoms were assessed every eight hours. Patients were diagnosed with a PDPH if a headache developed within five days after dural puncture. Patients who did not develop a PDPH within 48 hours were discharged home and followed up with daily for fourteen days. An EBP was administered for patients with a persistent severe headache after 48 hours of conservative treatment. A second EBP was performed if the headache did not improve within 24 hours.

Hakin (2010) found 15 patients (33%) in the treatment group suffered from PDPH when compared to 31 patients (68.9%) in the control group ($P = 0.001$). Significantly fewer patients in

the treatment group required an EBP (P = 0.035). However, the number of patients who needed a repeat EBP was comparable in both groups (P = 1.0). They also found that the time from dural puncture to PDPH occurrence was significantly longer in the treatment group (27 hours) when compared to the control group (17 hours) (P = <0.001). This study concluded that prophylactic cosyntropin administration after a dural puncture significantly decreased the incidence of a PDPH.

A prospective, randomized multi-center study by Hanling, Legrew, Colmenar, Quiko & Drastol (2016), evaluated the efficacy of IV cosyntropin compared to an EBP for refractory or severe PDPH. The patient population consisted of 28 patients who were diagnosed with a severe PDPH. Patients were randomized to receive an EBP or IV cosyntropin. In the EBP group, an EBP was performed to normal standards. In the IV cosyntropin group, patients received 500 micrograms in one liter of normal saline over one hour. Patients who received IV cosyntropin could receive an EBP if the pain continued after initial treatment. All patients were evaluated immediately after treatment, one day, three days, and seven days using a self-reported verbal pain and function score.

Hanling et al. (2016) found that an EBP showed significant improvement in PDPH over IV cosyntropin at day one (P <0.001). However, IV cosyntropin showed a similar effect to EBP on the day of the procedure, day three, and day seven. There was no significant difference in efficacy in patients who received an EBP following IV cosyntropin. Sixty percent of patients who received IV cosyntropin returned to the ED compared to eight percent treated with an EBP. Sixty-seven percent received additional conservative treatment. In this study, patients were able to receive and EBP if they were initially treated with cosyntropin, altering the outcomes.

Additional Treatment Options

Conservative treatments include bed rest, intravenous and oral fluids, and abdominal binders. These all have shown to provide some relief but currently there is insufficient evidence recommending their use. However, it is recommended that normal hydration be maintained with oral fluids, and by intravenous methods if unable to be taken orally (Russell et al., 2019, Omole & Ogunbanjo, 2015).

While several of these conservative treatments are commonly used to treat a PDPH, no conclusive evidence supports the use of these as prophylactic interventions. Due to the parturients' hypercoagulable state, early ambulation is particularly important postpartum. These patients are at an increased risk of developing deep vein thrombosis and pulmonary embolism (Kwak, 2017). A Cochrane review by Arevalo-Rodriguez et al. (2016) found no evidence that suggested bedrest after a dural puncture is beneficial in preventing a PDPH (RR (risk ratio): 1.16, 95% CI: 1.02-1.32). The authors also concluded that bedrest most likely increased PDPH when compared to early ambulation (RR: 1.24, 95% CI: 1.04-1.48). Also, no evidence supported prophylactic fluid supplementation (RR: 1, 95% CI: 0.59-1.69) (Arevalo-Rodriguez et al., 2016)

Other invasive procedures include acupuncture, greater occipital nerve blocks, epidural medications and epidural fluids. Again, there is insufficient evidence recommending their use due to limited studies (Russell et al., 2019). Epidural morphine has shown promising effects in the prevention of a PDPH after dural puncture. However, it is not recommended due to limited data and the potential for adverse side effects (Kwak, 2017).

Additional pharmacological management includes caffeine, theophylline, gabapentin, pregabalin, hydrocortisone, adrenocorticotropic hormone, and sumatriptan. Caffeine administration has shown some short-term improvement in symptoms. It is suggested that the

mechanism of action is through cerebral vasoconstriction and increased CSF production. If caffeine is used, treatment should not exceed 24 hours and oral route is preferred. However, there is limited evidence to support its use as treatment. Non-steroidal anti-inflammatory drugs (NSAIDs) and opioids can also be used. However, they only offer temporary relief (Russell et al., 2019).

After accidental dural puncture during attempted epidural placement, some providers opt to thread an intrathecal catheter for 24 hours. This can be used to provide continuous spinal anesthesia. Some studies suggest this will decrease the incidence of a PDPH. It is thought that a spinal catheter triggers an inflammatory process and speeds up the closure of a dural puncture. It is important that this catheter is well labeled, and all anesthesia providers are aware that it is a spinal catheter. This precaution helps to prevent the injection of large epidural local anesthetic doses and total spinal anesthesia (Baysinger et al., 2016).

Discussion

Although treatment options for PDPH are limited, preventing and recognizing symptoms with aggressive treatment and follow-up can decrease morbidity and mortality. EBP is the gold standard treatment for PDPH. However, non-invasive treatment options are gaining more popularity. Although limited, literature supporting SPGB for the treatment of PDPH found that it can be an effective alternative treatment. Most patients reported relief after the block was placed. Cohen et al. (2018) reported patients had PDPH relief quicker with a SPGB when compared to EBP and had fewer side effects. Two case studies, Channabasappa et al. (2018) and Kent & Mehaffey (2016), found patients to have significant PDPH relief following a SPGB. Both case studies had small sample sizes but reported significant results. Another study (Schaffer et al.,

2015) recommended SPGB for the treatment of chronic headaches. They found that SPGB decreased headaches as well as an associated symptom of nausea in 50% of the study population.

Studies supporting SPGB for the treatment of PDPH are limited. However, it should be considered if an EBP is contraindicated or if a headache cannot be treated. SPGBs are easy to administer, safe, have minimal side effects, and have been effective in a small sample size. The procedure, type and dose of local anesthetic varied among all studies. This may be due to the unavailability of local anesthetics within their facilities and varying hospital protocols. Further investigation into the efficacy of SPGB in larger sample sizes and with more uniform procedures is needed.

There are also limited studies supporting the effectiveness of IV cosyntropin on PDPHs. A 2015 Cochrane review by Ona et al. assessed the efficacy of certain drugs for treating PDPH. The authors concluded that there was a lack of conclusive evidence to support the use of IV cosyntropin. Hakim (2010) found that IV cosyntropin administration following a dural puncture significantly decreased the incidence in PDPH and the need for an EBP. However, Hanling et al. (2016) reported no significance in IV cosyntropin administration. All studies consisted of small sample sizes and varied doses of IV cosyntropin. Few studies actually compared the effectiveness of IV cosyntropin to an EBP. It may be reasonable to consider IV cosyntropin for patients when an EBP is contraindicated or if there is limited or no access to trained anesthesia providers to administer it. Cost analysis of IV cosyntropin should be considered as well.

It is important for anesthesia providers to have a general understanding and knowledge of alternative treatments for a PDPH. The articles included in this paper offer an informative background and bring out many strengths and weaknesses to the research. However, further

research must be done to compare the effectiveness of SPGB to EBP and IV cosyntropin to EBP before recommending a change to practice.

Conclusion

Obstetric patients are a unique population that commonly receive neuraxial anesthesia to obtain pain relief during labor and delivery, while keeping them and the fetus safe. PDPHs are a severe and debilitating complication of neuraxial anesthesia, and this population is at an increased risk due to their gender and young age. Anesthesia providers play a crucial role in prompt recognition and treatment of PDPHs. An EBP remains the gold standard and primary treatment for a PDPH and conclusive research supports this. However, it is an invasive procedure with the potential of adverse complications. Many patients decline, and many have contraindications to an EBP. SPGB and IV cosyntropin are effective and safe alternatives to an EBP, if it is contraindicated. Additional research is recommended to further evaluate the effectiveness of a SPGB and IV cosyntropin in treating PDPHs.

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