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The Safety and Efficacy in Reversal of Neuromuscular Blockades with Sugammadex versus Neostigmine

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ANESTHETIC CONSIDERATIONS FOR THE PARTURIENT WITH IDIOPATHIC INTRACRANIAL HYPERTENSION

By

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Abstract

Title: Anesthetic Considerations for the Parturient with Idiopathic Intracranial Hypertension

Background: Idiopathic intracranial hypertension (IIH) is a rare condition occurring in one in about every 5,000 obese women of child-bearing age. The disease process places affected patients at risk for permanent vision loss if treated improperly. Disease pathology, management and anesthetic considerations are important to avoid this potential unfortunate outcome.

Purpose: The purpose of this independent project is to present a case report of a parturient with idiopathic intracranial hypertension and provide anesthesia practitioners with a comprehensive evidence-based review of the anesthetic considerations for the parturient with the disease.

Process: A literature review was conducted using the UND Health Sciences Library through the University of North Dakota. Databases searched within the library included the Cochrane Library, PubMed, CINAHL, & SCOPUS. Each article identified through these databases were scrutinized for inclusion within the literature review.

Results: IIH is an uncommon condition with a high risk of morbidity if there is poor anesthetic planning. The patient may be allowed to labor and undergo vaginal or cesarean delivery. Epidural anesthetics should be administered carefully, and boluses should be avoided making this an unwise choice with the risk of any labor course requiring an emergent cesarean delivery. Spinal anesthetics may be employed if there is no lumboperitoneal (LP) shunt present. Use of an intrathecal catheter is beneficial for the administration of medications, monitoring of cerebral spinal fluid pressures, and treatment of therapeutic removal of cerebrospinal fluid (CSF) if the patient's neurologic condition deteriorates. With the presence of an LP shunt, epidural anesthesia is possible and with care exercised for correct interspace placement and removal of the catheter to avoid damaging of the shunt. Although there is a fair amount of research on the medical management of IIH, research on the anesthetic implications for patients with the condition is fairly limited. No national guidelines exist for obstetrical care of the parturient with IIH. Further research is required to produce a consistent guide for treatment in this patient population.

Implications: To allow for safe anesthetic planning, it is crucial that the anesthetic provider understands the pathophysiology, medical and surgical management, and anesthetic implications involved in caring for the parturient with IIH to avoid potentially irreversible neurological complications.

Keywords: Idiopathic intracranial hypertension, benign intracranial hypertension, pseudotumor cerebri, obstetrical anesthesia, pregnancy, neuraxial anesthesia, cesarean section.

Anesthetic Considerations for the Parturient with Idiopathic Intracranial Hypertension

The anesthetist's role in obstetrics has become increasingly important with nearly four million births per year in the United States of which 32% of all births come through cesarean section (Martin, Hamilton, Osterman, Driscoll, & Mathews, 2017). Osterman and Martin (2011) report that 61% of parturients received a spinal or epidural anesthetic to aid with their delivery in 2008. According to the American Society of Anesthesiologists (2016), obstetrical anesthesia refers to anesthetic and analgesic interventions delivered in the peri-partum timeframe to relieve pain associated with labor, vaginal delivery, cesarean delivery, the removal of retained placenta, or post-partum tubal ligation. Although the females receiving obstetrical services are usually healthy, co-existing conditions may exist that may complicate the anesthetic plan.

Idiopathic Intracranial Hypertension (IIH) is a rare but serious condition that has implications for obstetrical anesthesia (Kesler & Kupferminc, 2013). IIH, also known as pseudotumor cerebri or benign intracranial hypertension, is a rare condition that causes an increase of intracranial pressure (ICP) without a determined pathology existing in the brain or cerebral spinal fluid (CSF) composition (Karmaniolou, Petropoulos, & Theodoraki, 2011). Because common forms of obstetrical anesthesia include epidural and spinal anesthetics, it is important to understand the pathophysiology of IIH, the disease management, and the anesthetic implications for this rare patient population to avoid unfortunate neurologic sequelae (Kesler & Kupferminc, 2013). According to Month and Vaida (2012), IIH occurs in 0.9 per every 100,000 people in the general population but increases to 3.3 per every 100,000 women ages 15-44. Bell (2016) reports the prevalence of IIH in obese women ages 15-44 years old at up to 21.4 women in every 100,000. Much has been written about the medical and surgical management of IIH. These interventions are important factors that may impact the anesthetic plans for patients undergoing either vaginal or cesarean deliveries. Understanding of the disease management is critical for this patient population as it carries high consequence for mismanagement of anesthetic plans.

Further research is required for the understanding of the pathophysiology of IIH among anesthetists and the impact of the condition on anesthetic choices. In the following pages, a case report of a patient with IIH will be discussed, as well as, an extensive literature review of the topic.

Purpose

The purpose of this independent study is to review a case report of anesthetic management of a patient with IIH undergoing a cesarean section delivery. A literature review will also be reported on the pathophysiology of the condition and the anesthetic implications it has for the parturient population. This topic, although rare, has important implications for the anesthetist related to the morbidity associated with mismanagement of the condition.

Case Report

A 21-year-old primiparous female presented at 37-weeks gestation for a planned cesarean delivery due to fetal presentation in the breech position. Her pregnancy was complicated with neck and shoulder pain of unknown origin that progressed to ringing in the ears, dizziness, nausea, vomiting, headache, and blurred vision. A diagnosis of IIH with papilledema was made after consultation with neurology and ophthalmology. After her initial diagnosis, she had been managed with one therapeutic lumbar puncture to drain excessive CSF in attempt to reduce pressure ICP. She was then managed medically with acetazolamide scheduled four times daily.

During her pre-operative assessment, she was noted to be 160 cm tall and 155.5 kg. She was alert and oriented and answering questions appropriately. She complained of a mild headache but denied visual disturbances. Other past medical history was significant for morbid obesity. Outpatient medications included the acetazolamide, acetaminophen as needed for pain, and a prenatal vitamin. She had no known drug allergies. Pertinent lab values for the procedure included hemoglobin of 12.1 grams per deciliter (g/dL), hematocrit 37%, and a platelet count of 191,000 per microliter (mcL).

Her physical assessment revealed a regular heart rate and rhythm and her lungs were clear to auscultation. She denied chest discomfort or shortness of breath with activity. An airway assessment revealed full dentition, full neck ROM, a thyromental distance of greater than three fingerbreadths, an inter-incisor distance of fewer than three fingerbreadths, and a Mallampati II airway. She did complain of uncontrolled reflux symptoms. She was NPO for greater than 8 hours. Pre-operative vital signs included blood pressure 130/70 mmHg, temperature of 36.0 degrees Celsius, heart rate 90/minute, respiratory rate 18/minute, oxygen saturation 98% on room air. She was assessed an American Society of Anesthesiologists (ASA) physical classification status three.

Upon transport to the operating room, the patient had a 1-liter (L) bag of lactated ringers infusing through a 20-gauge intravenous (IV) catheter placed in the left wrist. An IV fluid bolus was begun in pre-operative holding and continued throughout the transport. Upon arrival to the operating room, the patient assumed a sitting position on the operating room (OR) table. A blood pressure cuff, 5 lead electrocardiogram (EKG), and an oxygen saturation monitor were applied to the patient. Pre-procedure vitals included heart rate of 75/min., respirations 16/min., blood pressure 125/84 mmHg on the right arm, and oxygen saturation of 99% on room air. After sterile preparation of the lumbar spine for infection prevention, three milliliters (mL) of lidocaine 1% was injected subcutaneously in the L2-L3 interspace to provide local anesthesia for placement of the introducer. A 1 3/8 inch 20-gauge introducer was seated in the ligamentum flavum at the level of the L2-L3 interspace. A 25-gauge spinal needle was advanced through the introducer into the intrathecal space. Upon removal of the stylet, free-flowing CSF was confirmed. The medication syringe was attached, and a small amount of CSF was aspirated. After aspiration of CSF, 1.2 mL of 0.75% bupivacaine with 8.25% dextrose, 25 mcg of fentanyl, and 0.3 mg of preservative-free morphine was slowly injected into the intrathecal space. After withdrawal of the spinal needle and introducer simultaneously, the patient was placed in supine position with left uterine displacement. She denied changes to her mild headache and/or visual changes after the spinal injection.

Once she was assisted into surgical position, a nasal cannula (NC) with end-tidal CO_2 ($EtCO_2$) monitoring was placed on the patient with 3 liters of oxygen per minute flowing. A non-invasive temperature probe was placed in the right axilla. Vital signs were reassessed revealing blood pressure 112/60 mmHg, heart rate 94/minute, respiratory rate 18/minute, oxygen saturation 100% on 3L per NC. The patient also complained of nausea associated with the hypotension. She was treated with phenylephrine 100 mcg IV while the IV fluid bolus was continued. Ondansetron 4 mg was administered IV push for treatment of her nausea. Upon reassessment, her blood pressure was 108/54 mmHg and heart rate 100/min, an additional phenylephrine 100 mcg IV was administered. Another dose of phenylephrine 100 mcg IV and ephedrine 5mg IV was given after obtaining a blood pressure of 105/61 mmHg and a heart rate of 72/min. Additionally, Ephedrine 10 mg IV was administered for a blood pressure of 115/64 mmHg and a heart rate of 65/min. Finally, the patient required one last dose of ephedrine 5 mg IV three minutes later for a blood pressure of 120/70 mmHg and a heart rate of 70/min. The patient reported relief of her nausea with improvement of blood pressure and administration of ondansetron.

Upon assessment of the spinal anesthetic, it was determined that the patient had achieved a T6 level of anesthesia from the spinal administration. After preparation of the abdomen by nursing staff, a sterile drape was placed. Prior to skin incision, the patient received 2 grams of cefazolin via IV push. At the time of incision, vital signs were blood pressure 130/75 mmHg, temperature of 36.1 degrees Celsius, heart rate 80/minute, respiratory rate 18/minute, oxygen saturation 100% on 3 L per NC. Twenty-one minutes after placement of the spinal a viable baby girl was delivered. The placenta was delivered two minutes later and an infusion of 0.9% normal saline with 20 units of oxytocin was initiated.

Upon completion of the procedure by the surgeon, the patient was transported to the post-anesthesia care unit (PACU) via a stretcher. She continued to deny headache and visual changes. Assessment of sensation indicated that the patient had blockade of sensation to the T7 dermatome and was able to wiggle her toes. Intraoperatively, she received 2,700 mL of crystalloid IV solution. Blood and amniotic fluid lost during the procedure totaled 800 mL. Urine output for the case was 75 mL of clear yellow urine. Her stay in PACU was uneventful and she was transferred to the inpatient ward. The patient and her baby were discharged home three days later and she complained of only intermittent minor headache pain and surgical site pain.

Literature Review

To guide the search for literature and define the required search terms, a PICO question was created. A PICO question clarifies the search in terms of the population being studied (P), the intervention in question (I), the group/treatment to which the intervention is being compared

(C), and the outcome of the intervention (O) (Boswell & Cannon, 2014). This is done with the goal of accurately guiding the literature search by helping to eliminate extraneous material. In this format, the following PICO question was created for the anesthetic management of the parturient with idiopathic intracranial hypertension. In parturients with idiopathic intracranial hypertension (P), is neuraxial anesthesia (I) a safe option for management of vaginal or cesarean delivery (O) when compared to general anesthesia (C)?

Databases

A literature search was conducted through several databases available through the UND Health Sciences Library at the University of North Dakota. Through the Library, a search was conducted through the Cochrane Library, PubMed, CINAHL, and SCOPUS databases. The benefit of using these databases is the ability to access scholarly, peer-reviewed materials on the topic of interest. With the availability of information resulted from internet search engines, there is a significant amount of literature that contains personal opinion blogs, forums of discussion, and advertisements that are filled with biased information. Use of a reputable library database will help to improve the quality and reliability of results obtained from a literature search.

The PubMed database was accessed and medical subject headings (MeSH) were utilized to access articles. MeSH terms offer a controlled vocabulary thesaurus as a way to index terms and more effectively search MEDLINE, which is the largest database within PubMed (Richter & Austin, 2012). Although the condition is currently referred to as idiopathic intracranial hypertension, it was previously called pseudotumor cerebri due to the way symptoms suggested an intracranial tumor. When the term "idiopathic intracranial hypertension" is entered into a MeSH database, it suggests the MeSH term "pseudotumor cerebri". Pseudotumor cerebri was added to the search builder with the Boolean operator "AND" inserted after the term. Anesthesia was also entered into the MeSH search bar resulting in thirty-four options. From this list, spinal anesthesia, epidural anesthesia, and general anesthesia were selected and added to the search builder. The Boolean operator between each anesthesia option was “OR”. “Search PubMed” button was selected. Twenty-one articles resulted from the search. Seven articles were relevant to the search, but four were selected due to the age of some of the articles.

The Cochrane library is a collection of several databases that contain high-quality evidence to inform evidence-based practice in the healthcare setting. Two of these databases are the *Cochrane Database of Systematic Reviews* and the *Cochrane Central Register of Controlled Trials* (Cochranelibrary.com, 2018). These databases hold some of the highest levels of evidence available concerning healthcare related topics. Upon arriving to the Cochrane Library page, “Advanced Search” was selected. The Medical Terms (MeSH) tab was selected. Pseudotumor cerebri was searched and the button “Add to Search Manager” was selected. In the second search bar of the search manager, search terms of spinal anesthesia and epidural anesthesia were entered with the Boolean operator “OR” placed between them. When a search was conducted with these terms, only one result was found that was not applicable to this topic. When the MeSH term “pseudotumor cerebri” was searched alone, thirty-six results populated. None of the results were applicable to the topic of anesthetic management of the parturient.

Next, the CINAHL database was used. CINAHL is the Cumulative Index to Nursing and Allied Health Literature and utilized for access to many nursing journals for study. A total of four searches were conducted on CINAHL. Terms used for the first search included idiopathic intracranial hypertension and anesthesia. This resulted in one article that was a duplicate from the PubMed search. Idiopathic intracranial hypertension was then searched with the term pregnancy. This search resulted in 12 articles. Five of the articles applied to the topic with two of the articles being duplicate articles from the PubMed search.

Additional CINAHL searches were conducted with the term pseudotumor cerebri due to the popularity of the term in PubMed searches even though the correct term is now idiopathic intracranial hypertension. When combined with the term anesthesia, no articles were resulted. Using the term pseudotumor cerebri in combination with the term pregnancy also resulted in zero articles.

Utilizing the SCOPUS database, a search was conducted for idiopathic intracranial hypertension and anesthesia. The search resulted in thirty-nine articles. Limiters placed on the search included: publishing date of 2009-2018, English language, and articles and reviews only. These limiters resulted in twenty-one articles. Four of these articles were applicable to the topic, but two of them were duplicate articles.

In addition to these articles retrieved from the above databases, three articles were discovered through the review of bibliographies of the reputable articles that were found in the above literature search.

Review of Literature

In order to understand the anesthetic considerations for a parturient with IIH, it is important to first understand components of intracranial pressure, neuraxial anesthesia, as well as the diagnosis and pathophysiology of the disease. With the understanding of these key aspects, we can then begin to discuss the anesthetic considerations for this pathology within such a common patient population in anesthetic practice. The review of literature will progress through these topics accordingly.

Components of Intracranial Pressure

The rigid skull contains three components that make intracranial pressure. These three contents are brain tissue, blood, and cerebral spinal fluid (CSF) (Nagelhout & Plaus, 2014). Due to the rigidity of the skull, the volume contained in the skull must remain in a fixed, but regulated volume to prevent an increase or decrease of intracranial pressure (ICP) (Butterworth, Mackey, & Wasnick, 2013). The Monro-Kellie doctrine governs this regulation stating that any expansion in volume of tissue, blood, or CSF will result in a reduction in blood or CSF volume to compensate and reduce ICP (Leffert & Schwamm, 2013). Although small increases in ICP are well tolerated, problems may rise when pressure continues to rise (Leffert & Schwamm, 2013). When pressures continue to rise beyond what the contents can compensate for, untoward neurological sequelae can result with the end result of which is brain herniation (Butterworth et al., 2013; Nagelhout & Plaus, 2014; Oropello, Pastores, & Kvetan, 2017). According to Butterworth et al. (2013), compensatory mechanisms that adjust for increasing ICP include displacement of CSF out of the cranial vault into the spinal compartment, increased CSF absorption, decreased CSF production, and a decrease in cerebral blood volume.

Brain tissue makes up 80% of the total volume of intracranial contents (Butterworth et al., 2013). Brain tissue is minimally compressible and cannot be altered to accommodate increasing ICP (Leffert & Schwamm, 2013). Brain tissue can contribute to increasing intracranial volume and, therefore, contribute to increasing ICP, but it is not a contributor to the compensatory mechanisms to reduce ICP (Leffert & Schwamm, 2013). Cerebral edema can result from traumatic or atraumatic sources (Butterworth et al., 2013). Atraumatic sources of cerebral edema include tumors, electrolyte imbalances, infection, or ischemia (Butterworth et al., 2013). Traumatic injuries to the head can result in an inflammatory process that increases the amount of brain tissue in the rigid cranial vault (Hines & Marschall, 2012). Hines and Marschall (2012) go on to state that although there are medical interventions that can be attempted to reduce cerebral edema, the brain tissue does not have an ability to compensate for increasing ICP. Rather, it is dependent on CSF and cerebral blood flow compensation to reduce ICP to avoid neurological damage (Hines & Marschall, 2012).

Cerebral blood volume is the second component of intracranial contents and pressure and is able to compensate for increasing ICP (Butterworth et al., 2013; Nagelhout & Plaus, 2014; Leffert & Schwamm, 2013). Cerebral blood flow (CBF) plays a crucial role in providing brain tissue with oxygen, glucose, electrolytes, amino acids, and removal of metabolic waste products (Butterworth et al., 2013). Cerebral blood volume is approximately 150 mLs of fluid at any given time and influenced by the local tissue needs and arterial partial pressure of carbon dioxide (Butterworth et al., 2013; Nagelhout & Plaus, 2014; Leffert & Schwamm, 2013). Vasogenic edema, vessel rupture, and venous occlusion can all lead to an increase in ICP through the leakage of intravascular contents into the brain tissue (Anson, Vaida, Giampetro, & McQuillan, 2015). These pathologic processes will also increase ICP by preventing the free flow of CSF in the ventricles (Leffert & Schwamm, 2013). Cerebral blood flow is determined by five factors: cerebral metabolic rate for oxygen, cerebral perfusion pressure, venous pressure, the partial pressure of carbon dioxide ($PaCO_2$), and the partial pressure of oxygen (PaO_2) (Hines & Marschall, 2012). Although it may contribute to increasing ICP, cerebral blood volume is an important component of the compensatory mechanisms that control a rising ICP (Hines & Marschall, 2012).

Nagelhout and Plaus (2014) describe the secretion, absorption, and roles that CSF plays in the nervous system. They state that CSF flows in the subarachnoid space in the brain and spinal cord and plays an important role cushioning the brain, providing buoyancy, and promoting optimal conditions for brain function (Nagelhout & Plaus, 2014). In a normal healthy adult, there is approximately 150 mL of CSF circulating at any given time (Nagelhout & Plaus, 2014). Nagelhout and Plaus (2014) continue to state that CSF is produced by the ependymal cells of the Choroid Plexus, which is located in the Lateral, Third, and Fourth Ventricles at a rate of 20-30 mL/hr for a total of 400-500 mL of new CSF daily. CSF pressure, which is also known as ICP is between 5 and 15 mm Hg (Butterworth et al., 2013; Hines & Marchall, 2012; Leffert & Schwamm, 2013; Nagelhout & Plaus, 2014). Nagelhout and Plaus (2014) describes the flow of CSF from its place of creation to its place of absorption. They describe that CSF created in the Left and Right Lateral Ventricles will flow through the Foramen of Monro into the Third Ventricle where it is also produced. From the Third Ventricle, CSF continues through the Aqueduct of Sylvius into the Fourth Ventricle, which is another site of CSF production. From this point, CSF can flow through the Foramen of Luschka and Foramen of Magendie into the Subarachnoid Space of the brain and spinal cord. It circulates through to the Superior Sagittal Sinus where it is absorbed at the Arachnoid Villi at a rate that should be similar to the rate of production (20-30 mL/hr) (Nagelhout & Plaus, 2014). Reabsorption of CSF is dependent on the pressure gradient that exists between CSF and the venous system (Hines & Marschall, 2013). The Arachnoid Villi will empty into the intracranial venous sinuses, which are non-compressible venous networks incorporated into the skull (Butterworth et al., 2013).

According to Leffert and Schwamm (2013), problems can occur if there is obstruction of the flow of CSF or a mismatch of production and absorption of CSF. They go on to describe a situation when the free flow of CSF is obstructed between ventricles, the spinal cord, and the site of absorption in the Superior Sagittal Sinus resulting in a condition called Communicating

Hydrocephalus. If this condition occurs quickly, symptoms can be seen in minutes to hours, whereas a partial obstruction will occur over days to weeks and may be better tolerated (Leffert & Schwamm, 2013).

In the bony skull, the volume of total contents remains relatively constant because any increase in one factor will result in the decrease in volume of another factor (Anson et al., 2015). Intracranial compliance is defined as the change in volume for a change in pressure (Anson et al., 2015). Because the rigid skull does not change, the intracranial compliance curve is a result of the three elements of brain tissue, blood volume, and CSF (Anson et al., 2013; Butterworth et al., 2013; Hines & Marschall, 2012; Leffert & Schwamm, 2013). Brain tissue contributes to a steep section of the curve due to its non-compressibility, but the initial slope of the curve is more flattened because of the ability of blood and CSF being shunted to extracranial reservoirs when brain tissue volume increases (Leffert & Schwamm, 2013). After reaching a certain point, CSF and blood volume will contribute to rising ICP after compensatory measures have exceeded their ability to shunt fluids elsewhere to those reservoirs (Anson et al., 2015; Leffert & Schwamm, 2013). Once this ability to shunt and compensate is exhausted, small increases in intracranial volume from any of the three contributing factors will result in steep increases in ICP and the damage that accompanies it (Anson et al., 2015; Leffert & Schwamm, 2013).

Idiopathic Intracranial Hypertension

Idiopathic Intracranial Hypertension (IIH) was first described in 1897 by Quincke in a condition he described as "serous meningitis" (Worrell & Lane, 2007). The condition has been known by several names throughout the last century from serous meningitis, pseudotumor cerebri, benign intracranial hypertension, and finally, idiopathic intracranial hypertension (Worrell & Lane, 2007). IIH affects more females at a ratio of 8:1 (Evans & Lee, 2010). In the general population, it occurs at a rate of one in 100,000 with obese women in their child-bearing years being at highest risk at a rate of one in 5,000 (Evans & Lee, 2010; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013; Worrell & Lane, 2007). It is likely that anesthesia providers may see an increase in occurrence of the disease as the obesity problem continues to worsen (Moore et al., 2014). As the role of anesthesia assistance with analgesia during labor and delivery has increased, it becomes increasingly important to understand the implications of this intracranial pathology in order to provide a safe anesthetic to this patient population.

Evans and Lee (2010) state that 90% of patients with undiagnosed IIH will present with a headache. They continue to describe that the headache is reportedly worse in the morning with associated photophobia. Patients often report visual changes, as well as back, neck and shoulder pain (Karmaniolou et al., 2011). Up to 60% of cases have complained of nausea, vomiting, and even pulsatile tinnitus (Kesler & Kupferminc, 2013). Visual disturbance is the second most commonly reported complication of the disease process (Evans & Lee, 2010). Disturbances are characterized by visual field loss, loss of acuity, and double vision related to sixth cranial nerve palsy (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). Unfortunately, 10-20% of all patients with IIH will develop vision loss (Kesler & Kupferminc, 2013). The most telling sign of IIH is bilateral papilledema, but rarely, this may be absent or occur unilaterally (Karmaniolou et al., 2011). Papilledema is the result of bulging on the optic disc in the retina from increased ICP (Worrell & Lane, 2007). Although rare, IIH can progress to cause complete visual loss in patients that do not seek treatment (Evan & Lee, 2010; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013; Worrell & Lane, 2007).

IIH is described as a condition that has no known cause (Karmaniolou et al., 2011). It is characterized by increased CSF pressure that creates an ICP of greater than 20 mmHg with normal CSF composition and negative imaging for intracranial pathology (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). Although there have been no definitive discoveries of an etiology, several theories have been proposed for the origin of elevated CSF pressure including excessive production of CSF, a reduction in CSF absorption, or an increase in cerebral venous sinus pressure (Anson et al., 2015; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013; Worrell & Lane, 2007). Kesler and Kupferminc (2013) suggest that any theory that is proposed needs to account for the fact that IIH particularly effects obese women and should consider that hormones play a role in the cause of the disease.

According to Karmaniolou et al. (2011), diagnosis of IIH after a patient presents with signs and symptoms is essentially a diagnosis of exclusion. They continue to state that the assessment should be based on modified Dandy criteria for the diagnosis of IIH includes seven specific criteria:

> Symptoms of raised intracranial pressure, no localizing signs with the exception of sixth nerve palsy, CSF pressure of 25 mmHg or greater measured in the lateral decubitus position, normal CSF composition, patient awake and alert, normal neuroimaging studies without evidence of thrombosis, except for an empty sella, and no other explanation for the raised intracranial pressure. (p. 652)

Neuroimaging should be completed first to rule out intracranial space occupying lesions and assess for high CSF pressure (Anson et al., 2015; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). Magnetic resonance imaging (MRI) is the gold standard for imaging, but it is important to remember that contrast dye should be avoided in the parturient (Anson et al., 2015).

Kesler and Kupferminc (2013) provide a great run down on common differential diagnoses for patients that present with these symptoms during pregnancy. They describe the most common differential diagnosis includes venous thrombosis. They state that a dural venous thrombosis will behave very similar to IIH with symptoms of headache and papilledema (Kesler & Kupferminc, 2013). Nagelhout and Plaus (2014) describe the physiologic changes that predispose pregnant women to thrombosis. Although most of the coagulation factors are increased, hypercoagulability is predominantly related to increased levels of factor VII, VIII, IX, X, and fibrinogen (Nagelhout & Plaus, 2014). Venous thrombus can be ruled out with either a MRI or computed tomography venogram (Kesler & Kupferminc, 2013). Other differential diagnoses without a space occupying lesion include: anemia, certain medications (tetracycline, minocycline, doxycycline, nalidixic acid, nitrofurantoin, lithium, vitamin A, leuprolide acetate, stanozol, or growth hormone), meningitis (which would be excluded with normal CSF studies), hypoparathyroidism, and uremia (Kesler & Kupferminc, 2013).

IIH can range from uncomfortable head and neck pain to debilitating vision loss (Evans & Lee, 2010; Karmaniolou et al., 2011). Kesler and Kupferminc (2013) emphasize that it is crucial that the parturient is treated timely and managed appropriately to avoid progression of the disease. Kesler and Kupferminc (2013) state that the treatment of IIH can utilize medical and surgical approaches depending on the severity and the patient's response to treatment. Treatment is aimed at decreasing the production of CSF or displacing CSF from the subarachnoid space with a goal of symptom control and vision preservation (Kesler & Kupferminc, 2013).

A medically managed approach for IIH should include the management of weight, utilization of medications that reduce inflammation and production of CSF but may also include serial lumbar punctures to drain excess CSF (Month & Vaida, 2012; Karmaniolou et al., 2011;

Kesler & Kupferminc, 2013). The most common approach to medical management of IIH is scheduled acetazolamide (Month & Vaida, 2012; Kesler & Kupferminc, 2013; Karmaniolou et al., 2011). According to Karmaniolou et al. (2011), acetazolamide is a carbonic anhydrase inhibitor that is employed as a diuretic to decrease CSF production. They continue to discuss the fact that although the FDA has designated this a category C medication (showing adverse effects in animal studies), it has been used successfully to manage IIH. Long term use of acetazolamide is associated with acidemia (Month & Vaida, 2012). Medication regimens to reduce inflammation may be employed and would involve the use of corticosteroids (Kesler & Kupferminc, 2013; Month & Vaida, 2012). Month and Vaida (2012), state that further medical management may employ single or serial lumbar punctures to drain excessive CSF. Month and Vaida (2012) suggest removing 20-40 mL of CSF with lumbar punctures as symptoms appear despite non-invasive management. Karmaniolou et al. (2011) suggests utilizing an approach that drains CSF until the CSF pressure is less than 20 mmHg for symptom control.

Kesler & Kupferminc (2013) reveal that when medical therapy fails to control symptoms and disease progression, surgical intervention should be considered. They clarify this by saying that surgical intervention is typically reserved for patients in which severe or progressive visual loss is present. Optic nerve sheath fenestration (ONSF), lumboperitoneal (LP) shunts, or ventriculoperitoneal (VP) shunts can control the pressure on a continual basis to optimize ICP (Karmaniolou et al., 2011). LP or VP shunt placement has failed in approximately 50% of cases due to the gravid uterus and is preferably avoided (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). ONSF is ideally used to relieve pressure in the optic nerve sheath by creating a small window to drain fluid from the peri-optic subarachnoid space into the retrobulbar space (Kesler & Kupferminc, 2013). Kesler and Kupferminc (2013) elaborate that this approach specifically protects against vision loss by relieving pressure on the optic nerve and results in lower morbidity than does shunt placement. Again, surgical intervention is reserved for individuals in which medical therapy has failed due to risks associated with surgical intervention in the parturient (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013).

Anesthetic considerations for the parturient with IIH

Providing analgesia for labor and delivery in the parturient with IIH requires careful planning, review of the patient's history and management of their condition, as well as understanding of the disease pathology. In a healthy parturient, fluctuations in the intracranial contents due to the physiologic changes during labor and delivery are small enough to avoid complications associated with a sharp rise in ICP (Anson et al., 2015). In the parturient with IIH, the elevated CSF pressure has potential to disrupt the pressure/volume balance and may result in substantial increases in ICP and vision loss in the parturient (Leffert & Schwamm, 2013). With this being said, IIH is not a specific indication for cesarean delivery and patients can attempt and undergo vaginal deliveries (Evans & Lee, 2010; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013; Leffert & Schwamm, 2013). Uterine contractions and "pushing" associated with labor increases blood pressure, cardiac output, central venous pressure (CVP), and, as a result, will increase CSF pressure (Evans & Lee, 2010; Leffert & Schwamm, 2013). Although Kesler and Kupferminc (2013) indicate that a patient with IIH is not necessarily at high risk for visual loss, the patient must still be monitored throughout the laboring process to assess for neurologic and ocular complications.

Neuraxial anesthesia is the preferred route of anesthesia for the parturient due to the ability of the mother to be awake for the birth of her child and minimal effects to the fetus when compared to general anesthesia (Nagelhout & Plaus, 2014). General anesthesia can also mask neurologic symptoms if complications occur in the parturient with IIH (Karmaniolou et al., 2011). With this being said, it is important to consider the effects of neuraxial anesthetics on ICP when treating a patient with pre-existing elevated ICP (Leffert & Schwamm, 2013). Epidural administration for patients with IIH is acceptable with certain considerations (Anson et al., 2015; Karmaniolou et al., 2011; Leffert & Schwamm, 2013). Injection of medications into the epidural space may translate that increase in pressure into the intrathecal space (Anson et al., 2015; Karmaniolou et al., 2011; Leffert & Schwamm, 2013). Leffert and Schwamm (2013) state that increased pressure is translated upward into the cranium putting the patient at risk for morbidity. They continue to explain that increased ICP at baseline results in a more pronounced rise in ICP after epidural injection than those with normal ICP (Leffert & Schwamm, 2013). This pressure increase may vary with volume of injection and baseline ICP levels (Anson et al., 2015; Karmaniolou et al., 2011).

Another complication associated with epidural anesthetics is accidental dural puncture (Moore et al., 2014; Nagelhout & Plaus, 2014). Loss of CSF caused by accidental dural puncture is typically well tolerated in patients with IIH due to the excess amount of CSF produced (Moore et al., 2014). Therefore, occurrence of post-dural puncture headache (PDPH) is extremely low in IIH patients (Month & Vaida, 2012; Moore et al., 2014). Also, patients with IIH are not at risk for herniation related to rapid loss of CSF from dural puncture like other patient populations with increased ICP (Leffert & Schwamm, 2013). It is suggested that if epidural anesthesia is utilized, the medication should be administered through a slow infusion, rather than a bolus of medications to reduce the likelihood that rapid injection in the epidural space would translate to higher intracranial pressures (Anson et al., 2015; Karmaniolou et al., 2011; Leffert & Schwamm, 2013). Leffert and Schwamm (2013) suggest incremental dosing in the range of 5 mL every 5-7 minutes to avoid elevation of ICP. Additionally, when choosing epidural anesthesia, it is important to consider the possibility for emergent cesarean section delivery if complications occur and sequelae that could result from the need to bolus medications through the epidural catheter (Leffert & Schwamm, 2013).

Although spinal anesthetics are contraindicated in patients with increased ICP related to a space occupying lesion, it is not contraindicated in patients with IIH (Leffert & Schwamm, 2013). Spinal anesthetics can be used with success in patients with IIH, but care must be exercised as any volume added to the intrathecal space has the potential to be translated upward toward the cranium causing complications (Anson et al., 2015; Karmaniolou et al., 2011; Leffert & Schwamm, 2013). There have been several approaches described in the literature ranging from single shot injections to continuous intrathecal catheters that are also used as pressure monitors and therapeutic drains (Aly & Lawther, 2007; Anson et al., 2015; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013; Moore et al., 2014). Further considerations exist for those with implanted lumboperitoneal shunts (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013).

Spinal anesthetic variations for the parturient with IIH

For single shot spinal anesthetics, Month and Vaida (2012) suggest using a small atraumatic needle. They continue to describe the withdrawal of CSF prior to any injection to treat IIH symptoms (Month & Vaida, 2012). Month and Vaida (2012) also suggest using the smallest injectate volume possible to reduce the likelihood that increased pressure would be associated with the injection. At this time, we recall how important it is to obtain patient history anesthetic planning for all patients. For parturients with IIH, it is crucial that the anesthetist understands how the patient has been managed prior to administration of spinal anesthetics (Kesler & Kupferminc, 2013). A patient that has been treated aggressively with diuretics or serial lumbar punctures may be deficient of adequate CSF volume (Karmaniolou et al., 2011). Butterworth et al. (2013) reveal that dermatomal spread is greater in patients with a small volume of CSF. This could result in a high or even a total spinal (Karmaniolou et al., 2011).

A commonly described technique involves the use of an indwelling intrathecal catheter (Aly & Lawther, 2007; Karmaniolou et al., 2011, Moore et al., 2014). Karmaniolou et al. (2011) and Moore et al. (2014) described using the intrathecal catheter with success on patients laboring with eventual vaginal deliveries. Aly and Lawther (2007) describe a case in which the intrathecal catheter was utilized successfully for a parturient undergoing elective cesarean section delivery. The advantage to the intrathecal catheter is three-fold (Aly & Lawther, 2007 Karmaniolou et al., 2011; Moore et al., 2014). First, the use of an intrathecal catheter will allow the anesthetist to continuously provide labor analgesia to the patient. Second, the indwelling catheter will allow for the continuous monitoring of CSF pressure throughout the laboring process. Finally, if intervention is required for elevated CSF pressures or neurological decline associated with the laboring process, the indwelling catheter can be used as a therapeutic drain (Aly & Lawther, 2007; Karmaniolou et al., 2011; Moore et al., 2014). More research is needed regarding parameters of CSF monitoring and indications on when intervention is necessary. Moore et al. (2014) reported CSF pressures during the second stage of labor fluctuating between 25 and 27 mm Hg at rest and peaking at 60 mm Hg when pushing. None of the literature discussed a suggested volume to remove or target CSF pressure if intervention was needed for elevated CSF pressures or neurological symptoms occurring while the intrathecal catheter was in place. Although the use of an intrathecal catheter in the general population is associated with an increased risk of PDPH, the occurrence of PDPH in parturients with IIH is extremely low (Month & Vaida, 2012; Moore et al., 2014).

Month and Vaida (2012) described a combined spinal epidural (CSE) approach in two patients in which they slowly removed 5 mL of CSF prior to sub-arachnoid injection of anesthetics. This removal of fluid greatly improved patient symptoms with both patients reporting a significant reduction in headache pain (Month & Vaida, 2012). After the removal of fluid, an intrathecal injection of fentanyl 10 mcg was placed as was their practice for early labor, followed by placement of an epidural infusion catheter for continued analgesia during labor (Month & Vaida, 2012). After intrathecal injection, Month and Vaida (2012) reported placement of an epidural catheter with a slow epidural infusion of 0.125% bupivacaine and fentanyl 2 mcg/mL at a rate of 6 mL/hr. According to Month and Vaida (2012), the advantage to this approach includes the reduction in CSF volume and pressure with the removal of CSF prior to intrathecal injection. With the intrathecal injection, an epidural bolus was not required, rather a slow infusion was initiated for ongoing analgesia avoiding a sharp increase in CSF pressure associated with epidural bolus (Month & Vaida, 2012).

The previous paragraphs have discussed anesthetic considerations for the patient with IIH that has had symptoms controlled medically. Special considerations should be taken for patients with IIH whose condition is controlled with a surgical intervention. As previously mentioned, IIH patients with neurologic symptoms that cannot be controlled with medical management may be treated surgically with optic nerve sheath fenestration or a lumboperitoneal shunt (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). Neuraxial anesthesia administration for patients with an LP shunt is controversial for several reasons (Anson et al., 2015; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). Patients with LP shunts can be at risk for infection of the device and ineffective anesthetic administration (Anson et al., 2015; Kesler & Kupferminc, 2013). It is believed that intrathecal injection of local anesthetic may be redirected into the peritoneal space through the shunt resulting in poor anesthetic coverage (Karmaniolou et al., 2011; Kesler & Kupferminc, 2013). For this reason, Kesler and Kupferminc (2013) suggest general anesthesia for cesarean section despite the many risks associated with it. Although Anson et al. (2015) acknowledge the risk of damage or infection to a LP shunt with neuraxial anesthesia, they report safe anesthetics being administered through epidural administration. They elaborate further by saying that epidural injections can be done successfully if administered in another interspace from the shunt and radiographic imaging should be considered for placement in the correct interspace (Anson et al., 2015). Additionally, Karmaniolou et al. (2011) discuss the theoretical risk of infection of a shunt with introduction of a catheter, but do not advocate the use or disuse of prophylactic antibiotics. Finally, concerning removal of the epidural catheter, it is important to take care removing the epidural catheter due to the theoretical risk of entanglement of the catheter with the shunt (Karmaniolou et al., 2011). They suggest imaging studies be conducted if abnormal resistance is noted while removing the catheter (Anson et al., 2015; Karmaniolou et al., 2011).

Discussion

The patient in this case review was a primiparous female with a new diagnosis of IIH during her pregnancy. She was diagnosed and treated medically with one diagnostic and one therapeutic lumbar puncture and scheduled acetazolamide. She complained of a headache but denied visual changes with the condition. She presented for an elective cesarean delivery for a baby in the breech position. Based on her current symptomology and her medical management throughout her pregnancy, it was determined that a small volume single shot intrathecal injection should be used to provide anesthesia for her cesarean delivery. Spinal anesthesia is not contraindicated in patients with elevated ICP due to IIH. Anesthetic management during the cesarean section coincides with evidence that is discussed in the literature. During the procedure the patient denied worsening of her headache or development of visual changes.

Conclusion

IIH is a neurologic condition of unknown origin with the highest rate of occurrence in obese women of child-bearing age (Month & Vaida, 2012). Typically, patients present to primary care with vague symptoms of elevated ICP. The diagnosis of IIH is a diagnosis of exclusion using Modified Dandy Criteria (Karmaniolou et al., 2011). Although symptoms commonly involve head and neck pain, IIH can progress to cause neurologic complications including vision loss. The condition may be treated medically using steroids, carbonic anhydrase inhibitor diuretics, and/or serial lumbar punctures. Patients that do not respond to medical therapy may require surgical intervention with placement of lumboperitoneal shunts or optic nerve sheath fenestration to prevent vision loss.

IIH is an uncommon condition with a high risk of morbidity if there is poor anesthetic planning. With proper management the patient may be allowed to labor and undergo vaginal or cesarean delivery. Epidural anesthetics should be administered carefully, and boluses should be avoided making this an unwise choice with the risk of any labor course requiring an emergent cesarean delivery. Spinal anesthetics can be employed if there is no LP shunt present. Use of an intrathecal catheter is beneficial for the administration of medications, monitoring of CSF pressures, and treatment of therapeutic removal of CSF if neurologic condition deteriorates. With the presence of an LP shunt, epidural anesthesia is possible with care exercised for correct interspace placement and removal of the catheter to avoid damaging of the shunt. Although there is a fair amount of research on the medical management of IIH, research on the anesthetic implications for patients with the condition is fairly limited. No national guidelines exist for obstetrical care of the parturient with IIH. Further research is required to produce a consistent guide for treatment in this patient population.

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Appendix A

Anesthetic Considerations for the Parturient with Idiopathic Intracranial Hypertension

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Anesthesia in Labor and Delivery

- Over 4 million births per year in the U.S.
- 32% of all births come through cesarean section
- Approximately 61% of all parturients receive spinal or epidural anesthetics to aid with the delivery process
- Although women of child-bearing years are typically healthy, comorbidities may exist that require consideration for proper anesthetic planning

(Martin, Hamilton, Osterman, Driscoll, & Matthews, 2017; Osterman & Martin, 2011)

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Idiopathic Intracranial Hypertension

- Described in 1897 by Quincke
- Unknown cause
- Increased ICP in the presence of negative neuroimaging and negative CSF studies. Increased CSF volume present
- Has been known as: serous meningitis, pseudotumor cerebri, benign intracranial hypertension, and idiopathic intracranial hypertension (IIH)
- Occurrence: 1:100,000 in general population, but 1:5,000 in obese women of child-bearing age
- Despite its rare occurrence, it carries important considerations for neuraxial anesthesia that may result in permanent neurologic damage if not planned for appropriately

(Kesler & Kupferminc, 2013; Karmaniolou, Petropoulos, & Theodoraki, 2011; Month & Vaida, 2012)

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Idiopathic Intracranial Hypertension

SYMPTOMS

- Headache
  - Worse in the morning
  - Photophobia
- Back, neck, shoulder pain
- Nausea and vomiting
- Pulsatile tinnitus
- Visual disturbances
  - Related to 6th cranial nerve compression
  - 10-20% of cases progress to visual loss

(Karmaniolou et al., 2011; Kesler & Kupferminc, 2013)

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Diagnosis of IIH

Diagnosis made based on Modified Dandy Criteria with the presence of:

- Patient is awake and alert
- Symptoms of raised intracranial pressure
- No localizing signs with the exception of sixth cranial nerve palsy
- CSF pressure of 25 mmHg or greater in the lateral decubitus position
- Normal CSF composition
- Normal imaging studies without evidence of thrombosis, except for empty sella turcica
- No other explanation for the raised ICP

(Karmaniolou et al., 2011, pg. 652)

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Idiopathic Intracranial Hypertension

Treatment:

- Medical Management
  - Weight control
  - Diuretics
    - Acetazolamide
  - Anti-inflammatory drugs
    - Corticosteroids
  - Therapeutic lumbar punctures
- Surgical Management
  - Lumboperitoneal Shunt
  - Optic Nerve Sheath Fenestration

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Case Information

- Primary cesarean section for fetal presentation in breech position
- 21-year-old female
- 160 cm
- 155 kg
- ASA physical classification status: 3
- No known allergies

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Pre-operative Evaluation

Past Surgical History
- Negative

Past Medical History
- Primigravida 37-weeks gestation
- Morbid Obesity
- Idiopathic Intracranial Hypertension (IIH) [diagnosed this pregnancy]

Outpatient Medications
- Acetazolamide QID
- Tylenol PRN
- Multi-vitamin

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Pre-operative Evaluation History of Present Illness

- Pregnancy course complicated with neck/shoulder pain, ringing in the ears, dizziness, nausea, vomiting, headache, and blurred vision
- Consulted by Neurology and Ophthalmology
  - Neuroimaging and lumbar puncture were negative for pathology
  - Diagnosed with IIH with papilledema
- Managed with one therapeutic lumbar puncture after diagnosis
- Maintained with acetazolamide QID

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Pre-op Vitals:
TPR: 36.0, 90 bpm, 18/min
BP: 130/70 mmHg
SpO2: 98% on room air

Airway Assessment:
- Mallampati III
- Inter-incisor distance >3
- Full dentition and neck ROM
- Thyromental distance >3

Pertinent Lab Values:
Unremarkable
Hemoglobin: 12.1 g/dL
Hematocrit: 37%
Platelets: 191,000/mcL

Patient complained of a mild headache, but denied visual disturbances in pre-op

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Operative Course

- Anesthetic
  - Single shot subarachnoid block (SAB)
    - 1.2 mL of 0.75% bupivacaine with 8.25% dextrose
    - 20 mcg fentanyl
    - 0.3 mg morphine
  - *Patient denied worsening of headache or visual changes with SAB*
  - T6 dermatome level sensory block achieved
- Additional Medications
  - Ondansetron 4 mg
  - Cefazolin 2 grams
  - Phenylephrine 100 mcg x 3 for hypotension
  - Ephedrine 5-10 mg x 3 for hypotension
  - Oxytocin 20 units in 1 L Lactated Ringer's IV solution

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Operative Course

- Twenty-one minutes after placement of SAB a viable baby girl was born
- Fluid Totals:
  - 2700 mL crystalloid
  - 800 mL blood and amniotic fluid loss
  - 75 mL clear yellow urine
- *The patient denied headache or visual disturbance in PACU*
- Patient and baby were discharged home on post-op day 3 denying visual disturbance and complaining of only a minor headache

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Discussion

Components of Intracranial Pressure

- With the rigid skull, the volume must remain fixed, but regulated to prevent an increase or decrease in ICP
- Three components: Brain Tissue, Blood, and CSF
- Monro-Kellie Doctrine states that any increase in volume (tissue, blood, or CSF) will result in reduction of blood or CSF volume to maintain a relatively constant ICP
- Compensatory mechanisms for an increasing ICP:
  - Displacement of CSF into spinal compartment
  - Increased CSF absorption
  - Decreased CSF production
  - Decreased cerebral blood volume

(Butterworth et al., 2013; Leffert & Schwamm, 2013; Oropello, Pastores, & Kvetan, 2017)

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Cerebral Spinal Fluid

CSF flows in the subarachnoid space to cushion and provide buoyancy to the brain and promote optimal conditions for function

FLOW OF CSF:

- Produced in the ependymal cells of the choroid plexus
- Left & right venricles
- Foramen of Monro
- Third ventricle
- Aqueduct of Sylvius
- Fourth ventricle
- Foramen of Luschka & Magendie
- Subarachnoid space
- Superior sagittal sinus (site of absorption at the arachnoid villi)

CSF stats:

- 150 mL total volume
- Produced at a rate of 20-30 mL/hr
- 400-500 mL of new CSF is produced and absorbed daily
- Normal ICP 5-15 mmHg

(Nagelhout & Plaus, 2014)

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Idiopathic Intracranial Hypertension Anesthetic Considerations

- Pre-operative planning and understanding of how their conditions were managed is crucial
- ICP fluctuates naturally with the labor and delivery process
  - Uterine contractions and "pushing" increase central venous pressure, cardiac output, blood pressure, and ICP
- Any sustained elevation in ICP could potentially cause visual loss in the patient from pressure on the optic nerve
- IIH is not a specific indication for cesarean delivery and patients may attempt to undergo vaginal deliveries
- Close monitoring of the patient throughout the labor process for neurologic and ocular changes

(Anson, Vaida, Giampetro, & McQuillan, 2015; Evans & Lee, 2010; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013; Leffert & Schwamm, 2013)

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Idiopathic Intracranial Hypertension Epidural

- Pressure from an epidural bolus injection can be translated into the intrathecal space & upward into the cranium
- Pressure increase varies with volume of injection & baseline ICP levels
- Post-dural puncture headache (PDPH) occurrence is very low in IIH
- IIH patients are not at risk for tonsillar herniation with CSF loss like with other conditions of increased ICP
- Incremental epidural dosing of 5 mL every 5-7 minutes; typical infusion rates used during labor are safe in IIH
- Remember the inability to bolus medication through the epidural in case of emergent cesarean sections

(Anson et al., 2015; Karmaniolou et al., 2011; Leffert & Schwamm, 2013; Month & Vaida, 2012; Moore, Meela, Keally, Crowley, McMorrow, & O'Kelly, 2014)

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Idiopathic Intracranial Hypertension Single-shot Spinal Injection

- Subarachnoid block (SAB) is not contraindicated in IIH as it is with space occupying lesions
- Volume injected will translate pressure upward into the cranium potentially increasing ICP
- Month & Vaida (2012) describe withdrawal of 5 mL of CSF over 5 minutes prior to smallest effective volume injection
- If the patient has been managed aggressively with diuretics or lumbar punctures, recall that reduced CSF volume will result in greater local anesthetic spread from SAB
- For these reasons, studies suggest using the smallest effective volume when utilizing single shot injections

(Anson et al., 2015; Butterworth, Mackey, & Wasnick, 2013; Karmaniolou et al., 2011, Leffert & Schwamm, 2013)

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Idiopathic Intracranial Hypertension Indwelling Intrathecal Catheter

- Aly & Lawther (2007) and Moore et al. (2014) both describe using an indwelling catheter with success on laboring patients with both vaginal and cesarean deliveries
- Benefits to indwelling intrathecal catheter:
  - Provide continuous labor analgesia
  - Continuous monitoring of CSF pressure throughout laboring process
  - Use the catheter as a drain if neurologic status declines
- Moore et al. (2014) reported ICP ranging from 25 to 27 mmHg at rest peaking at 60 mmHg during pushing
- None of the literature suggested when to intervene or what CSF volume to remove if intervention was needed

(Aly & Lawther, 2007; Karmaniolou et al., 2011, Moore et al., 2014)

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Idiopathic Intracranial Hypertension
Combined-Spinal Epidural (CSE)

- Month & Vaida (2012) described a CSE technique that withdrew 5 mL of CSF over 5 minutes and instilled 10 mcg fentanyl intrathecally. Patients reported improvement of headache pain with removal of CSF
- They placed a epidural catheter with no bolus. An infusion of 0.125% bupivacaine with fentanyl 2 mcg/mL was infused at 6 mL/hr
- Advantage to this approach:
  - Withdrawal of CSF to control symptoms
  - Intrathecal fentanyl to eliminate need for bolus
  - Slow epidural infusion for continued analgesia
- Disadvantage: bolus required if conversion to emergent cesarean section

(Month & Vaida, 2012)

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Idiopathic Intracranial Hypertension
Patients with LP shunts or Optic Nerve Fenestration

- Neuraxial anesthesia controversial
  - Risk of infection of the shunt
  - Ineffective spinal administration – local anesthetic leaks into the peritoneum
  - Damage and malfunction of the shunt
- Kesler & Kupferminc (2013) advocate general anesthesia for c-section
- Karmaniolou et al. (2010) suggest performing epidurals on an alternative interspace than the LP shunt
- Consider prophylactic anti-biotics with neuraxial anesthesia in the presence of a shunt
- Perform imaging prior to the removal of the catheter to assure no shunt entanglement is present

(Anson et al., 2015; Karmaniolou et al., 2011; Kesler & Kupferminc, 2013)

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Recommendations

- Parturients with IIH may be allowed to labor and deliver vaginally or via cesarean section
- Epidural: Slow infusion is safe, but bolus should be avoided making this a poor choice with possibility of cesarean section
- Subarachnoid block may result in greater dermatomal spread if management has depleted CSF levels. SAB is a safe anesthetic route
- Intrathecal catheters have been used successfully to drain CSF, monitor ICP, and provide medication delivery
- Neuraxial anesthesia requires special attention in the presence of a lumboperitoneal shunt

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Conclusion

- Neuraxial anesthesia continues to be the anesthetic of choice for labor and delivery
- Idiopathic intracranial hypertension is a rare condition with potentially serious complications with poor anesthetic management
- Neuraxial anesthesia can be used effectively with certain considerations for the parturient in the labor and delivery time period

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