Obstetric Forum

Obstetrical anesthesia for a parturient with a ventriculoperitoneal shunt and third ventriculostomy

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Purpose: To describe the anesthetic considerations for a primiparous woman whose history included four neurosurgeries: ventriculoperitoneal (VP) shunt insertion, evacuation of a subdural hematoma, shunt revision, and third ventriculostomy for hydrocephalus secondary to aqueductal stenosis.

Clinical Features: A 37-yr-old G1, P0 woman with a VP shunt and third ventriculostomy was assessed in the Obstetrical Anesthesia Clinic at 36 wk gestation to consider analgesic options for labour and delivery and review anesthetic management in the event that an operative delivery was required. A third ventriculostomy had been performed when increased intracranial pressure and neurological symptoms reappeared despite the previous VP shunt. Pregnancy was uneventful and vaginal delivery was anticipated. She presented in spontaneous labour at 40 wk gestation. She declined analgesia throughout her four and a half hour labour. A mediolateral episiotomy was performed to facilitate spontaneous delivery of a 4,182 g female infant. Mother and baby were discharged home without incident after two days. She denied any problems, including headaches, on follow up at two and four weeks.

Conclusion: A review of the literature concerning pregnant patients with shunts found that both regional and general anesthesia has been used with no reports of complications directly related to anesthesia. No published cases describing labour analgesia for patients with third ventriculostomy were found. Two neurosurgeons advised that regional anesthesia was not contraindicated in such patients and that analgesia should be based on obstetrical considerations and the neurological status of the patient.

Objectif : Décrire les préoccupations anesthésiques concernant une primipare dont les antécédents comprennent quatre interventions neurochirurgicales : la création d'une dérivation ventriculopéritonéale (VP), l'évacuation d'un hématome sous-dural, la révision de l'anastomose et une ventriculostomie, comme traitement de l'hydrocéphalie secondaire à une sténose aqueducule.

Éléments cliniques : Une primigeste de 37 ans, G1 P0, ayant subi une dérivation VP et une ventriculostomie, a été évaluée à la Clinique d'anesthésie obstétricale à 36 sem de grossesse afin qu'on puisse envisager les choix anesthésiques en prévision du travail et de l'accouchement et revoir l'organisation anesthésique dans l'éventualité d'une césarienne. Une ventriculostomie avait été réalisée lorsque l'hypertension intracrânienne et des symptômes neurologiques sont réapparus malgré la dérivation VP exécutée antérieurement.

La grossesse s'était bien déroulée et on s'attendait à un accouchement vaginal. La patiente s'est présentée en travail spontané à 40 sem de gestation. Elle a refusé l'analgésie tout au long des quatre heures et demie du travail. Une épisiotomie médiolatérale a été exécutée pour faciliter la naissance spontanée d'une enfant de 4,182 g. La mère et le bébé ont pu quitter la clinique sans problème deux jours plus tard. Lors d'un suivi, à deux et à quatre semaines après l'accouchement, la patiente a confirmé l'absence de tout malaise, y compris de céphalées.

Conclusion : Un examen de la documentation concernant les femmes enceintes qui ont subi une dérivation a permis de constater que l'anesthésie régionale ou générale a été utilisée sans qu'on relate de complications qui y seraient liées directement. On n'a trouvé aucun article à propos de l'analgésie pendant le travail obstétrical de patientes ayant eu une ventriculostomie. Deux neurochirurgiens affirment que l'anesthésie régionale n'est pas contre-indiquée chez ces patientes et que l'évaluation de l'analgésie doit être basée sur des éléments obstétricaux et l'état neurologique de la patiente.

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Case Report

A 37-yr-old primiparous woman with a history of hydrocephalus was assessed in our high risk Obstetrical Anesthesia Clinic at 36 wk gestation to plan the analgesic and anesthetic management for her labour and delivery. She had been diagnosed with aqueductal stenosis at age 18 yr during investigation for primary amenorrhea. A computed tomography (CT) scan at that time revealed massive lateral ventricles with dilatation of the third ventricle. No cause for this was apparent and it was thought that the stenosis might have been congenital or related to varicella infection in childhood.

She underwent insertion of a ventriculoperitoneal (VP) shunt in early 1981. Her postoperative recovery was complicated by the development of a subdural hematoma. Although the hematoma was evacuated uneventfully, she subsequently required a shunt revision. Approximately nine months after revision of the shunt, symptoms of increased intracranial pressure reappeared. A ventriculostomy of the third ventricle was performed in early 1982. The CT scans over the following months indicated progressive reduction in size of the third ventricle with a return to normal size six months later. Throughout this time, the reservoir chamber of her VP shunt could be pumped easily and it refilled quickly. Her neurosurgeon recorded that resolution of the hydrocephalus could have been attributable to either the third ventriculostomy or to renewed VP shunt function.

The patient remained asymptomatic and was discharged from neurosurgical care in 1984. She had not been required to pump her shunt since then and was unsure whether or not it continued to function. There was no further neurosurgical follow up. Three years ago, she underwent a repeat head CT scan to rule out an intracranial cause for symptoms of nausea, headache and lethargy. The CT indicated that the shunt was *in situ* and the ventricles were of normal size. The symptoms were attributed to a viral flu-like illness.

During her assessment at the Obstetrical Anesthesia Clinic, the patient described an uneventful pregnancy with an active fetus. She wished to have a spontaneous vaginal delivery and was interested in learning about analgesic options in consideration of her previous neurological problems. She had had no previous difficulties with general anesthesia and denied having any allergies or taking medications. She was a non-smoker. System review was negative and physical examination was unremarkable. She was normotensive, had normal airway anatomy and the lumbar spinous processes were easily palpated. The shunt reservoir was located over the right occipital area and it did not compress with application of usual force.

The patient was highly motivated to try non-pharmacological methods of analgesia before requesting any medication. She was instructed in the use of nitrous oxide and opioid patient controlled intravenous analgesia. The possibility of pudendal block was discussed with her obstetrician. She was informed that experience with epidural analgesia was limited in parturients with VP shunts and non-existent for ventriculostomy. Her own neurosurgeon could not be contacted as he had retired. The advice and opinion of two neurosurgeons was sought to review the implications of epidural analgesia for a patient with questionable VP shunt function and ventriculostomy. On the basis of these discussions, we agreed that epidural analgesia would be available, if required. The procedure, its risks and benefits were explained.

The patient presented to the labour floor in spontaneous labour at 40 wk gestation. Although she was offered several analgesic options, she declined analgesia throughout her four and a half hour labour. She described satisfactory pain management with use of a jet shower and breathing exercises learned in prenatal classes. First stage labour was uneventful and the second stage lasted 30 min. A mediolateral episiotomy was performed under local anesthetic infiltration to facilitate spontaneous vaginal delivery of a 4,182 g female infant. Apgar scores were 9 at one and five minutes. Mother and baby were discharged home after two days without incident. At two and four week follow up telephone calls, the patient described feeling highly satisfied with her pain management. She was appreciative of the information provided at the clinic and felt well informed regarding the available analgesic options. She denied any postpartum problems, including headache.

Discussion

Before the advent of shunts for treating hydrocephalus, mortality was high and it was unlikely that women suffering from hydrocephalus would reach childbearing age. Today, anesthesiologists may encounter parturients who have been treated with various shunt configurations, third ventriculostomy, or more than one of these procedures. In the case presented, it was not known whether cerebrospinal fluid was draining from the third ventricle through the ventriculostomy or through the VP shunt. Anesthetic considerations for both of these possibilities are presented.

Third ventriculostomy

Third ventriculostomy to treat hydrocephalus involves perforating the floor of the third ventricle, to create a path for the flow of cerebrospinal fluid from the ven-

tricle into the subarachnoid space. The procedure was first described in the 1920s¹ and was the only available treatment for hydrocephalus until the advent of shunting systems. The latter became the mainstay of treatment.^{2,3} There has been renewed interest in third ventriculostomy in the last ten years with the development of flexible endoscopes that permit visualization of the ventricular system, thereby increasing the safety of the procedure.

Promising results have been achieved when third ventriculostomy has been used to treat acquired aqueductal stenosis of adolescent or adult onset. In a review of studies that included 281 patients with this type of aqueductal stenosis, there was an overall success rate of 88%.⁴ Patients whose hydrocephalus resulted from myelomeningocele, intraventricular hemorrhage,² congenital aqueductal stenosis or tumour have less favourable results.³ The criteria for determining the success of the procedure is usually whether or not the patient subsequently required shunt insertion.³ In a recent review article on third ventriculostomy the authors acknowledged that the long-term outcomes of the procedure are unknown.²

The outcome for the patient described in this case was successful in the sense that symptoms of hydrocephalus had not returned in the 17 yr following surgery. However, the patency of the ventriculostomy could not be determined by clinical findings alone, since it is possible that the indwelling shunt continued to function. Movement of cerebrospinal fluid through a ventriculostomy may be confirmed by sagittal flow-gated magnetic resonance imaging, injection of radioisotope into the lumbar space, isotope ventriculography or repeat endoscopy.³ The patient was not aware of having had any of these tests performed, and there was no documentation in her chart indicating otherwise.

When a third ventriculostomy is performed in patients with a shunt *in situ*, some neurosurgeons strongly advocate either removing the shunt hardware or ligating the distal end of the drainage tubing through a separate incision in the neck.⁴ This step is thought necessary to prevent intermittent reopening of the shunt resulting in diversion of cerebrospinal fluid away from the third ventriculostomy, leading to its closure. There is some controversy over the value of pumping a shunt to assess its patency. There is often little correlation between shunt function and what is noted on depressing the pump.

No references were found related to anesthetic considerations for patients who had undergone third ventriculostomy to relieve hydrocephalus. Two neurosurgeons were consulted and were of the opinion that placing an epidural in a patient with third ventricu-

lostomy was not contraindicated. If an inadvertent dural puncture did occur, they expected that management of symptoms with an epidural blood patch would be well tolerated.

Ventriculoperitoneal shunt

The first report of pregnancy and maternal shunt dependency was published in 1979.⁵ Additional case studies, small series and reviews of the literature⁶⁻⁹ have appeared since that time. Disparate conclusions can be drawn from these earlier reports. The most recent, helpful report, from an anesthetic point of view, was a series consisting of 77 pregnancies in 37 women.¹⁰ Epidural analgesia was used in 38% of vaginal deliveries and 50% of Cesarean sections. Spinal anesthesia was used in 9% of Cesarean sections and the remaining 41% were performed under general anesthesia. Concerns about hydrocephalus and the shunt were cited as the reason for general anesthesia in 22% of these cases. No patient in this series experienced complications directly associated with anesthesia. These authors included a cautionary note, stating that placement of an epidural block should be accomplished with extreme care to avoid dural puncture, potentially contaminating the cerebrospinal fluid space and altering differential pressure.¹⁰ Despite this, there is controversy as to how anesthesiologists should proceed in the presence of a shunt. The answer is not straightforward. Yet, it is encouraging that, in the absence of signs and symptoms of increased intracranial pressure, experience with regional anesthesia techniques for labour and operative delivery in this patient population is accumulating.

Owing to the relatively high occurrence of shunt-related complications during pregnancy and in the first six months postpartum, the authors of this and a previous review made the following observations:^{9,10}

1. Distinguishing transient third trimester headaches and other symptoms of shunt failure presents a clinical challenge. Headaches occur more frequently in the later stages of pregnancy and may result from the increasing size of the uterus and resultant increases in intra-abdominal pressure. Magnetic resonance imaging (MRI) is recommended as a safe and effective means of evaluating ventricular dilatation when patients exhibit symptoms.
2. No particular mode of delivery is preferred. Rather, decisions should be based on the neurological status of the patient and obstetric considerations.
3. A shortened second stage of labour may be desirable to prevent protracted Valsalva maneu-

vres and longer periods of increased intracranial pressure.

4. Cesarean section may be associated with the risk of intra-abdominal infection and adhesion formation around the distal end of the VP shunt catheter. The effectiveness of prophylactic antibiotic therapy is unknown, although its use to prevent a shunt infection may be sufficient to justify therapy if there are no existing contraindications.
5. Shunt failure in pregnancy occurs more frequently with VP shunts than with other shunt configurations such as ventriculoatrial (VA) shunts.

The Obstetrical Anesthesia Clinic provided an important venue to assess this patient electively. We valued the opportunity to obtain previous medical records, search current literature, consult with other specialists and address her questions and concerns.

We recommend a team approach involving anesthesia, obstetrics, neurology and nursing in order to select the most appropriate management options for parturients with indwelling shunts to relieve hydrocephalus as well as those with third ventriculostomies.

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COMMENTARY

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There is very limited anesthetic experience to guide the management of a pregnant patient with hydrocephalus and a shunt. Although the above report deals more with the neurosurgical management of hydrocephalus than the anesthetic management of such patients it adds to our knowledge and is most welcome.

I agree with the authors that optimum management and outcome for both mother and fetus requires close cooperation and collaboration among the obstetrician, neurologist/neurosurgeon and obstetric anesthesiologist. Patients should be in an environment where close monitoring of neurological signs and symptoms can take place and where facilities and equipment for managing acute raised ICP are readily available.

It is apparent that patients who are fully compensated with functioning ventriculo-peritoneal shunt or ventriculostomy may receive either general or region-

al anesthesia. Meticulous aseptic technique is essential for regional anesthesia and prophylactic antibiotics are generally recommended.¹¹ The mode of delivery depends upon obstetrical indications although some authors suggest shortening the second stage by the use of forceps or vacuum extraction. In contrast, patients with raised ICP and deteriorating neurological status should be managed aggressively in consultation with a neurosurgeon. General anesthesia is the technique of choice if anesthesia is required.

But, what about the patient with mild symptoms of raised ICP who otherwise is alert and cooperative but needs labour analgesia? If a patient does not wish or need labour analgesia, as in this report, there is no problem. What if she requests analgesia? We should examine the pharmacological alternatives. Opioids can depress respiration and lead to hypoventilation. This may result in hypercarbia or hypoxia – both of which are bad for raised ICP. Opioids can also alter the sensorium, making monitoring of neurological status more difficult. An awake, cooperative patient is the best monitor for measuring changing neurologic status and, I believe, continuous lumbar epidural analgesia is the best option. Although a large epidural bolus of local anesthetic solution can raise ICP transiently, this can be minimized by slow injection and by using small bolus doses.

What if the dura is punctured? This should not be a problem with Idiopathic Intracranial Hypertension, but can pose difficulties in the patient with non-communicating hydrocephalus. In the latter situation one should be prepared to undertake swift and aggressive neurosurgical measures to treat this complication. The epidural should be inserted by the most experienced anesthesiologist to reduce the likelihood of inadvertent dural puncture. Once the epidural is *in situ*, anesthesia for Cesarean section block can be induced slowly.

Let us look at a different scenario. The patient has signs and symptoms of mild to moderate increased ICP but is alert and cooperative. There suddenly is severe fetal bradycardia. If the patient has normal airway anatomy then one can choose general anesthesia. But, if she has a difficult airway or you question your chance of establishing an airway quickly or easily, what is the role of spinal anesthesia? I could find no information on how much CSF leak develops after dural puncture with a #27 g Whitacre needle. The low incidence of post-dural puncture headache (PDPH) suggests that it is small. The alternative of a difficult or failed intubation, with the resulting increase in ICP associated with multiple attempts at intubation, can be harmful to the patient. In my view, spinal anesthesia using a small 27 g or 25 g Whitacre needle, is preferable.

COMMENTARY

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The case report by Littleford *et al.* discusses modern obstetrical management of women with ventriculoperitoneal (VP) shunts. This is a situation which may confront physicians more often as women with conditions leading to hydrocephalus are now likely to survive to childbearing age. However, the authors have managed to avoid discussion of some of the finer details of the controversies surrounding management of such patients as their particular patient did not require anesthesia.

The major concerns of an anesthesiologist caring for a parturient with a VP shunt or ventriculostomy are: present control of ICP, functioning of the shunt, risk of infection (meningitis) with the use of regional anesthesia/analgesia, risk of tonsillar herniation in the case of dural puncture, risk of shunt malfunction following regional anesthesia and/or treatment of its complications, and management of postpartum headache. The etiology of the patient's hydrocephalus may or may not be important. Certainly, patients with normal pressure hydrocephalus or pseudotumour cerebri are at no risk of brain herniation in the event of dural puncture. Functioning of the shunt can be easily ascertained on clinical questioning in the majority of cases, as in this particular case report. Testing the palpable reservoir of the shunt is unlikely to be of any benefit according to the neurosurgeons at my institute. However, previous articles discussed the use of intermittent pumping or even direct aspiration of the reservoir to control increases in ICP.¹² Radiological imaging, such as CT scanning or MRI, is not indicated on a routine basis in the parturient as long as she remains clinically well.

The ever-mentioned but never proved concern of introducing a shunt infection or meningitis with the use of regional analgesia/anesthesia in patients with VP shunts must be addressed. The use of the usual strict aseptic technique in the provision of epidural or spinal anesthesia is an adequate precaution. Our neurosurgeons, like those in the case report, do not have any concern about introduction of infection by use of regional analgesia in this patient population. However, I think a specific mode of labour analgesia that may pose additional risk is combined spinal-epidural analgesia. There are several case reports of meningitis associated with this procedure, some in which no organism was identified (possibly chemical meningitis) but, in

others, normal skin flora were isolated as the pathogens.¹³⁻¹⁵ This technique may confer additional infectious risk and the etiology is not obvious. It may occur because additional equipment is added to the epidural tray or because medication in non-sterile drug vials, opened with non-gloved hands, are injected intrathecally. Finally, regarding risk of infection, should these patients be covered with prophylactic antibiotics? There is no agreement in the literature. At this time of antibiotic resistance, antibiotics should be given to this population only if additional risk is present such as fever or change in neurological status.

Parturients appear to be at a relatively high risk of shunt malfunction during their pregnancy.¹⁶ One postulated etiology is that, as pregnancy progresses, the increase in intra-abdominal pressure causes retrograde or absent flow in the shunt. This has not been proved. However, concern about retrograde flow and subsequent increased ICP has led to the perpetuated practice of minimizing second stage effort, suggesting that these patients have assisted vaginal deliveries with good analgesia. There is no validation to this concern, and women with normal ICP who are shunt dependent are not at risk of sudden neurological decompensation. Given the increase in ICP seen with uterine contractions and pain, it is felt that flow will be sustained overall in the appropriate direction.^{16,17}

Concern about dural puncture, accidental or intentional, causing brain herniation¹⁸ is another interesting topic. Patients with controlled ICP via their shunt will simply compensate for the decrease in CSF pressure by having less flow through the shunt. Intentional dural puncture with current, small gauge, atraumatic spinal needles results intuitively in low CSF volume losses given the low incidence of symptomatic post-dural puncture headache (PDPH). A recent *in vitro* study of spinal needles and CSF leak rates has been published. In 1998, Holst compared 22 g with 27 g Quincke needles with a similar range of pencil point needles. The Quincke needles showed a two to three times greater loss of CSF over five hours (which allowed for dural retraction forces to take place) than the same size of pencil point needles. Over the five hour period, a 27 g Whitacre hole lost 11.8 ml of CSF, the 25 g Whitacre 25 ml, a 26 g Atraucan 9.4 ml and the 27g Quincke 31 ml of CSF.¹⁹ Given that CSF formation in the adult is $0.3 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ or about $20 \text{ ml} \cdot \text{hr}^{-1}$ on average, one can see that there would not be a large differential gradient created by dural puncture with a small gauge pencil point spinal needle. Accidental dural puncture with a large gauge epidural needle should be treated in the same manner as in non-shunt dependent patients, although perhaps one

would want to decrease the pressure gradient of the leak immediately by placing the patient supine. Patients with benign intracranial hypertension do not have the mass effect that causes brain herniation. Patients with intracranial mass lesions do not fall into the same category, and are not usually considered candidates for regional anesthesia.

Another area that was not discussed in this case report is the management of a postpartum shunt-dependent patient who had regional anesthesia for delivery and develops headache. How should this be assessed and investigated? Obviously, a thorough clinical examination is warranted considering the main differential diagnoses: postdural puncture headache, meningitis, and raised ICP secondary to shunt malfunction. Examination would include checking for the postural nature of the headache, evidence of nuchal rigidity, and looking for papilledema. If the headache is not clearly secondary to a dural puncture, then an early CT scan or MRI to check ventricular size (comparing with a previous one when the patient was asymptomatic for control!) may be warranted, as may early initiation of antibiotic therapy for treatment of possible meningitis. Of course, consultation with a neurosurgeon is also a good idea!

How should PDPH be treated? Should an epidural blood patch be offered? What are the risks of chemical meningitis, infectious meningitis, or a sudden symptomatic increase in ICP (as ICP does rise with performance of an epidural blood patch), or shunt occlusion by blood? Epidural blood patches are not contraindicated in these patients but strict asepsis, especially during the blood collection, is mandatory. Although we know that some blood from an epidural blood patch may cross the dural hole it would be considerably diluted by CSF. A shunt should not occlude from a few red blood cells passing through it. There is no reason to assume that these patients are at higher risk of chemical meningitis than a non-shunted patient. One perhaps would be hastier in instituting antibiotic therapy if, clinically, the patient appeared to have developed meningitis. Our neurosurgeons have no particular concerns about epidural blood patches in these patients.

Dr. Littleford's case report lists some recommendations from two articles in the neurosurgical literature which include: a shortened second stage, use of prophylactic antibiotic therapy, and warnings about epidural analgesia and the potential for dural puncture and altering differential pressures.^{9,10} However, neither of these review articles provides any scientific basis or clinical validation from other studies for these recommendations. In fact, the authors mention that

there is no evidence that the increased intra-abdominal pressure during second stage pushing has any effect on shunt function. Also, only recent shunts (within two to three months of insertion) are at particular risk of infectious-related complications. There are no reports of neurological sequelae following use of regional analgesia/anesthesia in these patients. A cynic might perhaps say that is because so few regional procedures have been used in this population. But given the paucity of clinical evidence to support these fears, perhaps it is time anesthesiologists used their regional anesthesia skills more often in these patients!

This case report stimulates discussion on the use of regional analgesia in parturients with VP shunts and third ventriculostomies who have controlled ICP. The literature indicates a continuing reluctance to use epidural or spinal anesthesia in these patients for reasons that have no supportive clinical evidence. This report will hopefully help other anesthesiologists to overcome their reluctance to use these techniques, recognizing the potential complications and their management. Perhaps the only specific warning would be to use absolutely strict aseptic techniques, and consider very carefully the potential increased risk of meningitis with CSE techniques. If a CSE is felt to be optimal, then a bacterial filter (for what it is worth) and sterilized packages of drugs for intrathecal injection should be used.

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