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CLINICAL REPORT

Obstetric and anesthetic management in parturients with ventriculoperitoneal shunt: a case series

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Abstract
Further study is needed to determine the safest mode of delivery and anesthetic management for parturients with ventriculoperitoneal shunts (VP). Prior recommendation for delivery in women with ventriculoperitoneal shunts was cesarean delivery. However, both vaginal delivery and neuraxial anesthesia have been shown to be safe in women with appropriately functioning VP shunts. We present a case series of parturients with VP shunt. Parturients with VP shunts were identified and VP shunt placement indications, neurologic symptoms during pregnancy, delivery mode, anesthetic type, and postpartum complications were reviewed. Forty patients were identified, and fifteen women with twenty deliveries were included. Two women experienced neurological symptoms during pregnancy and one required postpartum shunt revision for blurry vision and ataxia. There were ten cesarean deliveries and ten vaginal deliveries (eight normal spontaneous, one vacuum assisted, and one forceps assisted). Assisted vaginal deliveries were performed to decrease Valsalva including the patient with neurological symptoms related to shunt malfunction. Of the vaginal deliveries, six (60%) had epidural analgesia. Anesthesia for cesarean delivery included neuraxial anesthesia ($n=5$) and general anesthesia ($n=5$). In our cohort, women with VP shunt received neuraxial blockade without complication. Neuraxial techniques should be offered to women with appropriately functioning VP shunt.

Keywords Case series · Hydrocephalus · Neuraxial analgesia · Neurologic disease · Ventriculoperitoneal shunt

Introduction

Ventriculoperitoneal (VP) shunt is the most common procedure performed for the management of hydrocephalus. As more patients with VP shunts are reaching childbearing age, it is important for anesthesiologists to be prepared to manage them in the peripartum period.

Shunt failure in the non-pregnant population affects about half of patients within the first 2 years after placement [1]. Both the anatomic and physiologic changes that occur during pregnancy may make the parturient with a VP shunt at even higher risk of shunt malfunction. The gravid uterus may cause mechanical obstruction of the shunt, and an increase in intraabdominal pressure may also cause it to malfunction [3].

There is no consensus on the safest delivery mode for patients with VP shunts. Previously, there was concern regarding vaginal delivery that contractions, labor pain, and Valsalva with pushing may increase intracranial pressure (ICP). Currently, vaginal delivery is the preferred mode of delivery in women with functioning VP shunts; however, cesarean delivery (CD) is recommended if the shunt is malfunctioning or there is concern for elevated ICP [2]. CD is not without risk in patients with VP shunt. Damage to the catheter, adhesion formation around the tip, or infection can all occur [3]. Furthermore, the safety of different anesthetic techniques for the parturient with a VP shunt is not well studied. Both neuraxial and general anesthesia have been used successfully in these patients during pregnancy [4, 5].

We conducted a retrospective review of patients with VP shunts to evaluate obstetric management, anesthetic management, and shunt function in the peripartum period.

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Methods

The Mayo Clinic Institutional Review board approved this study and the requirement for written informed consent was waived. We performed a retrospective chart review of mothers with VP shunts who were evaluated during their peripartum course at Mayo Clinic in Rochester, Minnesota and in the Mayo Clinic Health System. Patients were identified from an institutional database of pregnant and postpartum women evaluated by neurology and neurosurgery between January 1, 2000 and December 31, 2016. Additional patients were identified by searching an institutional database for patients who had a delivery in their record and had a VP shunt between January 1, 2000 and May 15, 2023. The electronic medical record was manually reviewed for each patient. Neurology and neurosurgery notes were reviewed to assess VP shunt placement indications, neurologic concerns during pregnancy, and peripartum complications. In addition, emergency department visits during pregnancy were reviewed for shunt malfunction. Demographic, obstetric, and anesthetic data were manually extracted from perinatal visits, hospital summaries, anesthesia record, and neuraxial procedure notes.

Results

Forty patients were identified, and fifteen women met inclusion criteria. A total of twenty deliveries among fifteen parturients were included (Fig. 1). Patients were excluded if they did not have a VP shunt ($n=9$) or did not have a VP shunt present in the peripartum period ($n=6$). The other patients excluded were children misidentified by our database ($n=10$). Patient demographics and neurologic histories are listed in Table 1.

Two out of fifteen women experienced shunt malfunction during pregnancy. One patient (Table 1; #7) had a shunt that was noted to be questionably working, yet the patient was asymptomatic and there was no increase in ventricle size on imaging. The second patient (Table 1; #8) experienced blurry vision, ataxia, incontinence, and memory problems. She subsequently developed progressive catatonia. Of note, she had an extensive work up that was relatively unremarkable. Her symptoms slowly

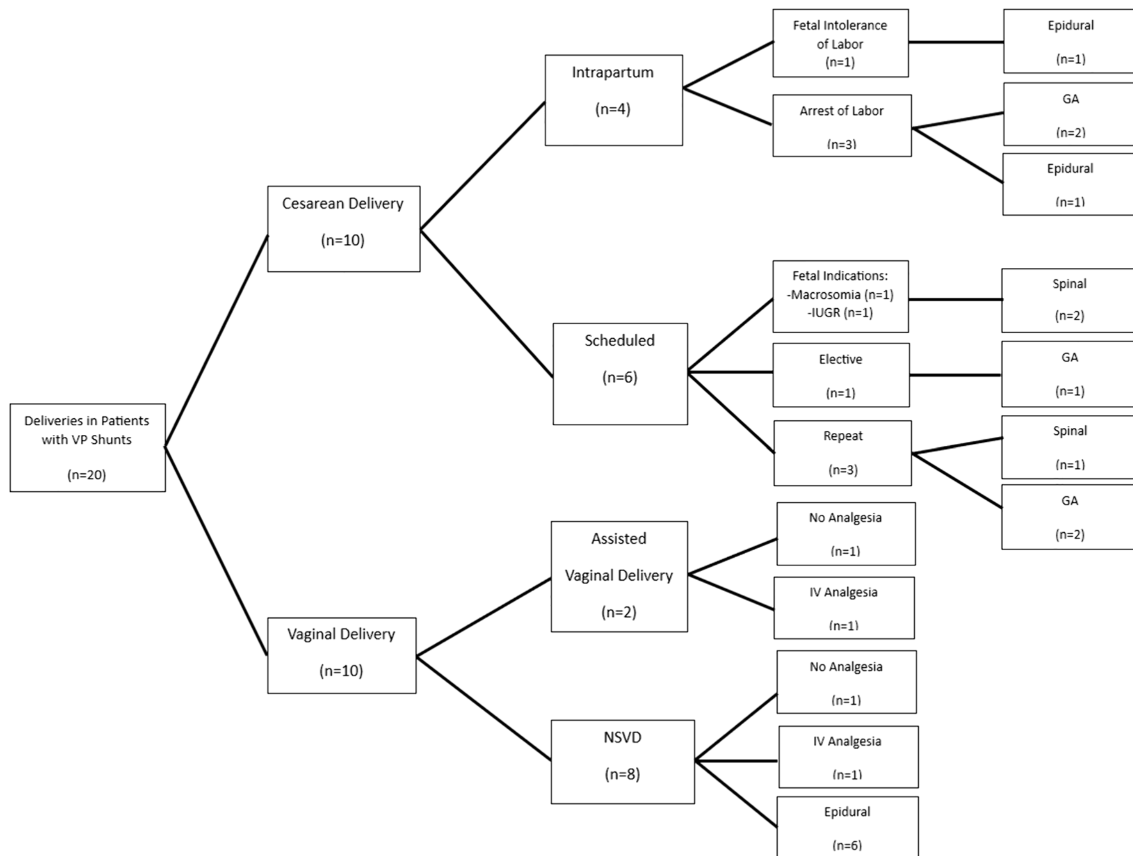

Fig. 1 Obstetric and anesthetic management of patients with ventriculoperitoneal shunt *VP* ventriculoperitoneal shunt, *GA* general anesthesia, *NSVD* normal spontaneous vaginal delivery, *IV* intravenous, *IUGR* intrauterine growth restriction

Table 1 Demographic and neurologic history

Patient #	Age at Delivery	Gravidity (G)/ Parity (P)	BMI	VP Shunt Indication	Age at VP Shunt placement (years)	VP Shunt Malfunction during Pregnancy?	Symptoms of Malfunction	Management of Malfunction
1	23	G2P1	24	Idiopathic hydrocephalus	< 1	No		
2	38	G2P1		Childhood meningitis	13	No		
3	30	G5P1		Pseudotumor cerebri	27	No		
4	31	G1P0	32.9	Meningomyelocele	< 1	No		
5a	37	G4P2	29.0	Congenital hydrocephalus	< 1	No		
5b	39	G5P3	28.3			No		
5c	41	G6P4	27.5			No		
5d	42	G7P5	30.3			No		
6	27	G2P1		Congenital hydrocephalus	5	No		
7	24	G2P0		Hydrocephalus after motor vehicle accident	6	Questionable	None	None
8	29	G2P1		Idiopathic hydrocephalus	28	Yes	Blurry Vision, ataxia, incontinence progressive catatonia	Revision
9	28	G2P1	34	Intraventricular hemorrhage with hydrocephalus after perinatal stroke	23	No		
10a	27	G1P0	27	Hydrocephalus from prematurity	< 1	No		
10b	28	G2P1	27.4			No		
11	35	G2P1	29	Idiopathic hydrocephalus	< 1	No		
12	22	G1P0		Hydrocephalus from meningocele and meningoencephalocele	< 1	No		
13	39	G2P0		Dandy Walker malformation with hydrocephalus	5	No		
14a	31	G1P0	31.86	Chiari Type II malformation, myelomeningocele with hydrocephalus; conus terminates at S2	< 1	No		
14b	34	G2P1	33.98			No		
15	40	G5P3		Pseudotumor cerebri	37	No		

BMI body mass index, *VP* ventriculoperitoneal

improved following her delivery; however, on postpartum day eleven, she developed neurologic decline secondary to distal shunt occlusion and required shunt removal with extraventricular drain placement which resolved her symptoms. No other patients underwent revision of their shunts in the peripartum period.

Obstetric and anesthetic management are detailed in Table 2. Ten (50%) deliveries were by CD. Six were scheduled CD and four were unplanned. Two parturients underwent planned CD due to history of VP shunt. Anesthesia for CD included neuraxial anesthesia ($n = 5$, 50%) and general anesthesia ($n = 5$, 50%). General anesthesia was

Table 2 Obstetric and anesthetic management in parturients with ventriculoperitoneal shunts

Patient #	Mode of Delivery	Indication for Delivery Type	Gestational Age (week + day)	Apgar Score (1 and 5 min)	Birth Weight	NICU Admission?	Anesthesia for Delivery	Anesthetic Management
1	CD	Arrest of descent	40 + 6	7, 8	4050	No	Epidural	LEA:bupivacaine 0.125% with fentanyl 2 mcg/mL; 12 mL/h; CD: Lidocaine 2%, fentanyl, & morphine
2	NSVD		39 + 6	9, 9		No	Epidural	Ropivacaine 0.125%-fentanyl 1 mcg/mL
3	NSVD		37 + 2	8, 9	2750	No	None	
4	Vacuum	Assist with Valsalva	38 + 3	8, 9	3385	No	None	
5a	NSVD		38 + 4	NA	NA	NA	Epidural	Ropivacaine 0.125%-fentanyl 1 mcg/mL
5b	NSVD		38 + 0	NA	NA	NA	Epidural	Ropivacaine 0.125%-fentanyl 1 mcg/mL
5c	NSVD		NA	7,9	NA	NA	Epidural	Ropivacaine 0.125%-fentanyl 1 mcg/mL
5d	CD	Macrosomia	39 + 3	8, 9	4900	No	Spinal	NA
6	NSVD		38 + 2	8, 9	3010	No	IV analgesia	Nalbuphine 10 mg
7	NSVD		39 + 2	8, 9	3580	No	Epidural	Ropivacaine 0.2%-fentanyl 2 mcg/mL, 9–10 mL/h
8	Forceps	Assist with Valsalva	37 + 2	8, 9	2920	No	IV Analgesia	Nalbuphine 10 mg, meperidine 25 mg
9	CD	Severe IUGR with critically abnormal Doppler; preeclampsia with severe features	26 + 5	2, 6	620	Yes	Spinal	Bupivacaine 0.75% 1.6 ml, fentanyl 15mcg, hydromorphone 0.075 mg
10a	CD	Arrest of dilation	40 + 5	9, 9	4025	No	GA	Propofol, fentanyl, succinylcholine, desflurane, rocuronium
10b	CD	Repeat CD	39 + 5	8, 9	3850	No	GA	Desflurane, rocuronium
11	CD	Repeat CD	39 + 1	9, 9	3460	No	Spinal	Bupivacaine 0.75% 2 ml, fentanyl 20mcg, morphine 0.1 mg
12	CD	Failed induction and maternal spina bifida	38 + 2	8, 9	3270	No	GA	Ketamine, thiopental, succinylcholine
13	CD	Fetal intolerance of labor	39 + 2	7, 8	3300	No	Epidural	Ropivacaine 0.2%-fentanyl 2 mcg/mL

Table 2 (continued)

Patient #	Mode of Delivery	Indication for Delivery Type	Gestational Age (week + day)	Apgar Score (1 and 5 min)	Birth Weight	NICU Admission?	Anesthesia for Delivery	Anesthetic Management
14a	CD	Primary CD, patient declined trial of labor without neuraxial analgesia due to maternal spina bifida	36 + 1	6, 7	2540	No	GA	Propofol, rocuronium
14b	CD	Repeat CD; preeclampsia with severe features	36 + 5	3, 6	2590	No	GA	Ketamine, propofol, rocuronium, succinylcholine
15	NSVD		39 + 0	10, 10	4150	No	Epidural	Bupivacaine 0.125% with fentanyl 2 mcg/mL

NICU neonatal intensive care unit, *CD Cesarean Delivery*, *NSVD Normal Spontaneous Vaginal Delivery*, *IV* intravenous, *IUGR Intrauterine Growth Restriction, VP Ventriculoperitoneal*, *NA* not available in the record, *LEA* labor epidural analgesia, *GA* general anesthesia

recommended due to history of VP shunt in patient 10, although the VP shunt appeared to be working at the time of delivery. Patients 12 and 14 had maternal meningocele.

Ten of twenty deliveries (50%) were vaginal delivery (eight normal spontaneous vaginal deliveries, one forceps-assisted vaginal delivery, and one vacuum assisted vaginal delivery). The parturient with notable neurologic symptoms had a prior vaginal delivery, presented with spontaneous onset of labor, and subsequently had forceps-assisted vaginal delivery without complication. Both assisted vaginal deliveries were performed to decrease Valsalva. Of the vaginal deliveries, six (60%) had epidural analgesia, two (20%) received intravenous opioid analgesia, and two (20%) were unmedicated.

Discussion

Complications with VP shunts can occur in the peripartum period, and any neurologic changes should be assessed. Two of the most common complications are malfunction and infection. In a case series and literature review of cases in 1991, Wisoff et al. reported that out of 17 pregnant women with VP shunts, 59% developed symptoms of elevated ICP and 23% required shunt revision [6]. Cusimano et al. reported in 1990, 43% of pregnant patients experienced symptoms of shunt malfunction [7]. Wisoff et al. and Cusimano et al. share many of the same cases reported in the literature. A more recent review of the literature in 2017 by Rajagopalan et al. reported 29% of pregnant women developed shunt malfunction and 71% of these women required shunt revision [3]. In our cohort, there was a lower incidence of shunt malfunction (10%) and need for revision for shunt malfunction (50%), but this may be a result of reporting bias in the published cases.

Though there is concern during labor and delivery that uterine contractions and pain may result in acute increases in ICP, half of the deliveries in our cohort were uncomplicated vaginal deliveries [8]. Of note, two of these deliveries were assisted vaginal deliveries to minimize Valsalva. The patient with neurologic symptoms in her pregnancy and delivery had a forceps-assisted vaginal delivery to minimize Valsalva. She had no neurologic complications during delivery. Her case adds evidence that assisted vaginal delivery with minimization of Valsalva is safe when a parturient has neurologic symptoms from shunt malfunction; however, further study is warranted.

One patient (#10) was recommended a CD with general anesthesia due to the fact she had a VP shunt, although the shunt appeared to be functioning at the time of delivery. The other two patients (#12 and #14) who received general anesthesia for cesarean delivery occurred in the setting of maternal spina bifida with contraindications for neuraxial blockade and was not related to VP shunt. The mode of delivery should be dependent on obstetric indications in the setting of a working shunt. In the presence of neurologic deterioration and shunt malfunction, neurological consultation should be considered to determine the optimal route of delivery.

Neuraxial techniques have been used safely in paturients with properly functioning cerebrospinal fluid (CSF) shunts [3, 6]. Over half of the vaginal and cesarean deliveries in our series utilized neuraxial analgesia without complication.

Neuraxial techniques in parturients are rarely associated with meningitis [9]. Theoretically, a parturient with a VP shunt could be at risk of contamination and subsequent malfunction. Leffert and Schwamm recommend in the presence of obstruction of CSF in hydrocephalus, or findings suggestive of elevated ICP, that neurologic consultation occur prior to proceeding with neuraxial technique as patients are at mild-to-moderate risk of herniation during accidental or intentional dural puncture [10]. The parturient who had neurologic symptoms in our cohort was not offered neuraxial analgesia and utilized intravenous analgesia with nalbuphine and meperidine. Remifentanil or fentanyl patient controlled intravenous analgesia or inhaled nitrous oxide are alternative options for labor analgesia when neuraxial analgesia is not offered. In parturients having CD, some authors recommend the preferred anesthetic method for parturients with compromised intracranial compliance to be general anesthesia; however, general anesthesia is not without risk [3, 6]. In pregnant patients with signs of elevated ICP, there should be goals to minimize Valsalva during induction and emergence from general anesthesia. In addition, the sympathetic response to intubation should be blunted with opioids or labetalol. Likewise, maternal $PaCO_2$ should be kept between 25 and 30 mmHg as hyperventilation can compromise placental blood flow [10]. Our series adds to existing published literature that neuraxial techniques can be used safely in patients with properly functioning shunts. We advise performing a thorough neurologic assessment prior to any neuraxial technique.

Our investigation has the inherent limitations of a retrospective review, such as potential missing or incomplete data and uncertainties regarding the rationale behind management decisions. This is a small sample of patients with VP shunts and precludes us from being able to provide conclusive recommendations. Large, prospective studies are needed to establish a robust foundation for the safe management of parturients with elevated ICP and VP shunts.

In conclusion, our case series reinforces the safety of neuraxial techniques in parturients with properly functioning VP shunts. In the setting of elevated ICP, if there is no obstruction of CSF flow from a mass occupying lesion, then risk of herniation from an intentional or unintentional dural puncture is low. Parturients with CSF flow obstruction are at risk of acute neurological deterioration and neurological consultation is recommended. Generally, cesarean delivery should be reserved for obstetric indications. If parturients have signs of elevated ICP, multidisciplinary planning for mode of delivery should occur and CD or assisted vaginal delivery should be considered.

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Data Availability All data generated or analysed during this study are included in this published article.

Declarations

Conflict of interest None.

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