ORIGINAL ARTICLE

Emergency Cesarean Section in a Parturient with Ruptured Sinus of Valsalva under Spinal Anesthesia: A Case Report

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ABSTRACT

Ruptured Sinus of Valsalva (RSOV) is a rarely encountered cardiac anomaly that can potentially lead to adverse clinical outcomes. RSOV increases the risk of morbidity during pregnancy due to the physiological changes associated with gestation, that can exacerbate the underlying cardiac pathology.

We present the case of a 29-year-old female with an uncorrected RSOV who required an emergency cesarean section for abruptio placenta. The patient underwent the procedure under spinal anesthesia, with careful titration of norepinephrine infusion and close monitoring of hemodynamic parameters using an invasive intra-arterial line.

Given the absence of established anesthetic protocols for parturients with RSOV undergoing cesarean delivery, a comprehensive understanding of the complex interaction between the hemodynamic effects of RSOV, pregnancy, and anesthesia is essential. This understanding enables the safe use of spinal anesthesia in urgent situations, leading to favorable patient outcomes.

Keywords: sinus of valsalva, aortic rupture, cesarean section, spinal anesthesia

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INTRODUCTION

Sinus of Valsalva Aneurysm (SOVA) is a rare disorder afflicting an estimated 0.09% of the general population.[1] The aneurysm is typically silent until it is complicated by rupture.[2] There is no published literature on the incidence of rupture, but it typically occurs at the second to fourth decade of life.[1] The anatomy and speed of which will determine its course, hemodynamic consequences, and prognosis.[1,3–5] In the non-pregnant patient, a Ruptured Sinus of Valsalva (RSOV) produces varying degree of symptoms, from mild to severe symptoms of congestive heart failure to symptoms of ischemic heart disease, arrhythmia, and even tamponade.[5–7] If the ruptured sinus is left untreated, the prognosis is poor, with life expectancy of one year depending on the degree and site of rupture.[1,8]

We are presented with a parturient with an unrepaired RSOV for emergency cesarean delivery. The coexistence of this condition together with pregnancy poses a higher risk for the parturient. Various physiologic changes in pregnancy can potentially put a strain on an already compromised cardiovascular state.[8,9] There is paucity of documented cases of RSOV in pregnant patients, as SOVA occurs more in males with a male to female ratio of 4:1.[10] Documented anesthetic management of patients who underwent cesarean

section is fewer, with most cases reporting a planned abdominal delivery under epidural anesthesia.[3,4,7] Review of the literature from 2010 to 2022 yielded only one report of an elective case done under general anesthesia and one under spinal anesthesia.[7,11] As of this writing, there is limited literature available regarding the anesthetic management of obstetric patients with uncorrected RSOV for emergent delivery. Given the absence of established management guidelines for these patients, a dilemma arose when selecting the appropriate technique. Ideally, the choice of anesthetic technique should be guided by the urgency of the cesarean section and the mother's cardiovascular status. In cases requiring an urgent cesarean section, the selected technique should facilitate a rapid onset of surgical anesthesia while causing minimal hemodynamic disturbance.

CASE PRESENTATION

A 29-year-old female was diagnosed with RSOV three years prior to the present admission, presenting as easy fatigability. She maintained good compliance while being managed for heart failure with preserved ejection fraction, functional class II. Being in a child-bearing age, she was classified as Class IV under the Modified WHO Maternal Cardiovascular Risk. She was advised to avoid pregnancy and undergo corrective surgery. In the interim, patient had improvement of symptoms until she conceived. She reported experiencing recurrent fatigue with moderate exertion and two-pillow orthopnea during her second trimester, without any accompanying pedal edema or chest pain. She had no other co-morbidities other than allergy to ibuprofen. She had her first pregnancy nine years prior to current admission, where she underwent cesarean section under spinal anesthesia due to non-reassuring fetal status. The Sinus of Valsalva aneurysm was not yet detected during this pregnancy. There were no feto-maternal complications associated with the procedure. In her current pregnancy, she has been receiving regular follow-up at the high-risk obstetric clinic with a long-term plan for assisted vaginal delivery.

On the day of admission, she presented with vaginal bleeding and labor contractions. Her obstetric diagnosis was G2P1 (1001) pregnancy uterine, 34 weeks and 4 days age of gestation, cephalic, in preterm labor. She was received at the admitting section with stable vital signs and no signs of cardiorespiratory distress. She weighed 71 kg, and stood at 153 cm, with a BMI of 27.8 kg/m^2. The heart rate had regular rhythm, with audible grade 4/6 holosystolic murmur heard best at the 2nd intercostal line, with thrills and heaves. The maximal apical beat was at 6th intercostal space, left anterior axillary line. She had no cyanosis, clubbing, and bipedal edema. She had no signs and symptoms of coagulopathy. Her baseline fetal monitoring showed a Category I trace with tachysystole. The baseline fetal heart rate was 140 beats per minute with moderate variability, and with accelerations but without decelerations. Contractions were moderate to strong, every 1-2 minutes, lasting for 60 seconds. Internal examination showed a closed cervix.

Her latest 2D echocardiography showed a windsock deformity of the right sinus of Valsalva with turbulent flow from the aorta to the proximal right ventricular outflow tract. The sinus was dilated at 34 mm. An increase in flow was noted since that last scan. There was an eccentric left ventricular hypertrophy with adequate wall motion and preserved overall systolic function with grade III diastolic dysfunction. The left and right atria were dilated. The right ventricle was dilated as well, with normal contractility and systolic function. There was mild regurgitation in the mitral, tricuspid, and pulmonary valves with mildly elevated pulmonary artery pressure. There was a small posterior pericardial effusion. The ejection fraction was estimated at 63%.

The initial plan was to control labor contractions until term. However, the persistence of tachysystole and uterine tenderness raised suspicion of abruptio placenta, necessitating an urgent delivery. A quick huddle with the surgical team led to the decision for a repeat low-segment cesarean section with intrauterine device insertion.

Due to the urgency of the case, there was no time to wait for the COVID test result, and the patient was transported to the COVID surgical complex. The patient arrived in the operating room with a baseline blood pressure of 130/60 (MAP of 83 mmHg), heart rate of 87, respiratory rate of 18, and oxygen saturations of 97% on room air. The baseline electrocardiogram displayed sinus rhythm, and she was comfortable lying flat on the operating table.

In addition to standard monitors, an arterial line was inserted. An intravenous infusion of plain lactated Ringer's solution was carefully regulated to run at a consistent rate of 100 ml per hour using an infusion pump. The patient received a premedication of ondansetron 4 mg IV administered slowly. Subarachnoid block was performed using a 25-gauge Quincke needle while in the left lateral decubitus position. A cautious administration of 12.5 mg of hyperbaric bupivacaine with 0.1 mg of morphine sulfate followed. Once the block height was established at the T6 dermatome, a pad was placed under the right hip to achieve a 15-degree left lateral hip displacement. Sympathectomy was achieved within 5 minutes, resulting in a blood pressure of 95/54 and a heart rate of 68. Norepinephrine infusion was initiated at 0.05 mcg/kg/min.

The most senior obstetrician on duty performed the surgery. The baby was delivered within 6 minutes, with an APGAR score of 9,9. Intraoperative findings revealed a partially detached placenta. Carbetocin 100 mcg was administered upon delivery over 1 minute, along with a loading dose of paracetamol 900 mg. Norepinephrine infusion was reduced to 0.03 mcg/kg/min 40 minutes into the surgery and was eventually discontinued after an hour. Mean arterial pressure was maintained at 70-75 mmHg, and heart rate ranged from 60 to 87 bpm. No episodes of desaturation or respiratory distress were observed. Local infiltration of the wound was performed using 0.25% isobaric bupivacaine, and

the surgery concluded after 1 hour and 28 minutes, with a total blood loss of 400 mL.

Postoperatively, the patient was admitted to the intensive maternal unit with the invasive intra-arterial line still in place. Diuretics were administered cautiously by the cardiology service. Her input and output were closely monitored, and she was observed for any signs of pulmonary congestion. She did not experience any episodes of hypotension, respiratory distress, congestion, or desaturation.

Pain control was effectively managed with round-the-clock intravenous paracetamol, which was later transitioned to oral administration, and there was no need for rescue opioids. Meanwhile, the baby was admitted to the neonatal ICU due to respiratory distress syndrome and received oxygen support. Both mother and baby were eventually discharged after 6 days. The mother was advised to continue follow-up with a definitive plan to proceed with open-heart surgery.

DISCUSSION

Given the unpredictable course of RSOV, which depends on the nature of rupture, it is vital to assess the patient's medical history and echocardiographic findings when planning the anesthetic management.[1] In the case at hand, echocardiographic assessment reveals a shunt from the high-pressure circulatory system into the low-resistance pulmonary circulation, resulting in observable signs of volume and pressure overload during echocardiography.[3,4,11] To anticipate events that may lead to hemodynamic compromise, it is crucial to correlate this information with the physiological adaptations occurring during pregnancy.[12]

Upon admission, the patient did not present with signs of congestion. In some RSOV cases, the heart can effectively compensate following the initial rupture.[11] Moreover, the pregnancy-induced reduction in systemic vascular resistance is advantageous in left-to-right shunts, as it minimizes the shunt flow.[3] Nevertheless, there is still a risk of shunt and volume overload during injudicious fluid administration or placental separation, which can potentially override this compensatory mechanism.[11] Failure of the maternal myocardium to accommodate this overload may induce acute heart failure.[3,12] This risk is heightened in this particular patient, given that her plasma volume is expected to increase by 50% at her current stage of gestation.[13,14]

Volume overload can also have a potential impact on other cardiac conditions. Regurgitant lesions, in general, tend to be well-tolerated due to the reduction in afterload caused by the low-resistance placental circulation and the decrease in systemic vascular resistance during pregnancy.[15,16] However, these valvular lesions might still be challenged with a sudden volume overload following delivery, which can result in pulmonary edema.[16] In cases of pulmonary hypertension, volume overload may also trigger right-sided heart failure, which carries an exceptionally high risk of mortality.[12,14,17] In this specific case, dilated right heart chambers with regurgitant valvular flows may have a limited capacity to accommodate rapid intravascular expansion.

With this understanding of the patient's cardiac lesions and physiology, the management focused on regulating parameters that were under the control of the anesthesiologist.[17] The priority for this patient was to maintain preload and myocardial contractility, prevent bradycardia, and avoid increase in systemic vascular resistance (SVR) and pulmonary vascular resistance (PVR).[7] The goal is to enhance forward systemic flow and reduce additional strain on the myocardium.

Currently, there is no available evidence to suggest a superior anesthetic technique, in terms of maternal outcomes, between general anesthesia (GA) and neuraxial anesthesia for parturients with congenital heart disease.[18] However, the decision to use a neuraxial technique was made to mitigate the occurrence of undesired hemodynamic effects associated with general anesthesia (GA). Firstly, GA has been linked to increased blood loss during cesarean sections due to the impact of volatile anesthetics on uterine activity.[18,19] This is particularly concerning in the context of cardiac disease, as anemia can have adverse effects on the patient.[7] Secondly, several induction agents used in GA have negative inotropic effects, potentially compromising myocardial contractility. Thirdly, wide hemodynamic fluctuations are expected during sympathetic stimulation, as occurs during laryngoscopy and extubation in GA. Lastly, positive pressure ventilation can elevate right ventricular afterload, a factor that may not be well-tolerated by patients with pulmonary hypertension.[8] While it's possible to mitigate some of these effects, a technique with fewer hemodynamic alterations may be more favorable in emergent situations. Furthermore, GA has been associated with suboptimal neonatal outcomes.[18,19] For these reasons, neuraxial anesthesia was chosen for this patient. Additionally, neuraxial anesthesia offers the advantage of decreasing SVR which is favorable for this patient with a left-to-right shunt. This promotes forward flow and reduces volume load on the right side of the heart.[3,4,7]

Several reports argue that epidural anesthesia is preferable to spinal anesthesia in patients with RSOV undergoing a cesarean section due to the more controlled sympathectomy provided by the former.[3,4] However, it is important to note that epidural anesthesia has a disadvantage of delayed onset, which is less ideal in emergent deliveries.[3,20] In the classification system of cesarean delivery urgency, placental abruption falls under category I. Multiple international guidelines concur that the decision-to-delivery interval should ideally not exceed 30 minutes.[21]

Combined spinal-epidural (CSE) anesthesia has been associated with better cardiovascular stability compared to spinal anesthesia in individual trials. However, in a meta-analysis conducted by Klimek and colleagues comparing CSE versus spinal anesthesia specifically for cesarean section, they found no significant difference in the use of vasopressors and the incidence of hypotension between the two techniques.

The study also revealed that the induction time is slightly longer with the CSE technique compared to the spinal technique. The analysis concluded that CSE does not have a clear advantage over spinal anesthesia.[22]

Meanwhile, in a Cochrane systematic review by Simmons and colleagues in 2019, they found no difference in the incidence of hypotension between CSE and high-dose spinal anesthesia; while there is a probable reduction in the incidence of hypotension in the CSE group compared to low-dose spinal anesthesia. However, these findings are based on limited data and the differences are unlikely to be clinically significant. Consequently, the authors concluded that there is insufficient evidence to support one technique over the other, and more studies are needed to further assess the relative safety of CSE and spinal anesthesia for cesarean section.[23] Hence, for this situation, spinal anesthesia was deemed an acceptable technique.

While a reduction in SVR during neuraxial anesthesia is desired, a profound decrease, as what can occur rapidly after spinal anesthesia, may potentially reverse the shunt, leading to maternal hypoxemia.[3] This was anticipated; thus, an intra-arterial blood pressure monitor was inserted before the induction of spinal anesthesia to closely monitor hemodynamic fluctuations and guide the titration of vasopressors.[12]

Hypotension was managed preferentially with vasopressors instead of fluid boluses upon assessing that the patient was adequately hydrated.[16] This approach aimed to prevent a sudden increase in preload and, as previously discussed, to avoid overloading the compensatory mechanisms that were in place. Furthermore, fluid infusion was meticulously controlled using an infusion pump to ensure a precise administration, preventing inadvertent boluses while simultaneously preventing underhydration.

Norepinephrine infusion was preferred over phenylephrine due to its lower incidence of bradycardia. Maintaining a higher heart rate is of particular importance in this patient with regurgitant valvular flows. Generally, slower heart rate can increase regurgitant flow and volume, potentially exacerbating ventricular overload.[24] A recent systematic review shows that norepinephrine exhibits similar safety profile and efficacy as phenylephrine in treating hypotension during cesarean section, with the advantage of less heart rate reductions.[25] The infusion was titrated to sustain a blood pressure near the patient's baseline. To further avoid a rapid decline in blood pressure, left lateral hip displacement was done to relieve aortocaval compression and improve venous return.[17]

A careful selection of uterotonics is crucial because these drugs can have vasoactive effects. Carboprost is not suitable for this patient as it may increase PVR. On the other hand, methylergonovine may increase both SVR and PVR.[12] Oxytocin and its analogue, carbetocin are the most suitable uterotonics for this patient as they only mildly elevate PVR and may decrease SVR. Carbetocin has the advantage of being administered as a single dose, in contrast to oxytocin, which is diluted in a large volume of fluids and administered through infusion. This eliminates the need for extended intravenous fluid infusion, which is especially important when fluid intake is being closely regulated. However, it is worth noting that bolus administration of carbetocin can lead to a sudden drop in SVR. Hence, it was administered slowly in this patient to mitigate this effect.[12,17,26]

As previously mentioned, an increase in PVR can have serious consequences. Therefore, precautions were taken to avoid conditions that might elevate PVR, including hypoxia, hypercarbia, and pain.[12] To prevent hypoxia, supplemental oxygen was administered, and the patient was closely monitored for signs of a high spinal block.

The absence of anxiety obviated the need for sedatives, which could lead to respiratory depression and subsequent hypercarbia. Additionally, the patient was thoroughly briefed about what to expect while under anesthesia, which contributed to improved patient cooperation.

In terms of effective post-operative pain management, intrathecal morphine was administered.[27] This approach was especially critical in this case, considering the patient's allergy to NSAIDs, which limited the choice of drugs for a multimodal analgesic regimen.

To ensure a swift surgical procedure and prevent the need for an extension beyond the duration of the spinal anesthetic, the most experienced obstetrician conducted the surgery. This approach was aimed at minimizing unnecessary pain and reduce the likelihood of conversion to general anesthesia.

The postpartum period imposes the greatest stress on a mother's cardiovascular system. Cardiac output can increase by as much as 100% due to uterine involution and the resorption of edema.[8] Consequently, monitoring the patient's fluid status is crucial, particularly since she was also placed on diuretics. While predicting fluid responsiveness using advanced hemodynamic monitoring is more established in mechanically ventilated patients, there is literature supporting its use in spontaneously breathing patients.[28] Therefore, the intra-arterial line was retained for this purpose.

On the other hand, the insertion of central venous line insertion for the purpose of hemodynamic monitoring was considered unnecessary. Existing literature suggests reserving it for cases involving mothers in a decompensating state.[8,12]

A potential contributor to the patient's positive outcome, despite her exceptionally high-risk condition, is her diligent compliance with prenatal management and follow-up.[29] After being categorized as Class IV according to the maternal risk stratification criteria, she had her prenatal care at our institution, that caters to high-risk obstetric patients and was overseen by a multidisciplinary team of specialists. This approach aligns with the recommendations of existing clinical guidelines.[14]

CONCLUSION

Spinal anesthesia is a safe technique for cesarean deliveries in patients with RSOV who are not experiencing

decompensation. Nonetheless, it is imperative to tailor its administration to the patient's current condition and take measures to mitigate any potential adverse cardiovascular effects.

Intensive monitoring should continue post-partum since this period poses the highest stress on the parturient's cardiovascular system. Vigilant assessment of fluid status and the utilization of advanced hemodynamic monitoring are paramount to ensuring the patient's safety during this critical phase.

The case underscores the importance of a coordinated, multidisciplinary approach and the need for meticulous planning to address the complex needs of high-risk obstetric patients. It is through such comprehensive care that positive outcomes can be achieved, even in the face of formidable medical challenges.

Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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