SOAP
Society for Obstetric Anesthesia and Perinatology

Simulation Patient Design (August 2023)
Case of Bradycardia after Neuraxial Anesthesia in a Pregnant Patient

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Introduction

Maternal bradycardia can occur during or immediately following administration of a neuraxial anesthetic in pregnant patients presenting either in the labor suite or in the operating room. Especially in patients whose cardiac output is disproportionately affected by the heart rate, any decrease in heart rate will have a direct effect on maternal blood pressure and uteroplacental flow.

Risk Factors

There are known risk factors associated with maternal bradycardia in the setting of neuraxial anesthetic administration in pregnancy. A high level of suspicion and expeditious identification of such risks can lead to the prevention of bradycardia and its downstream effects on the well-being of the fetus. Some of these risk factors include healthy patients without comorbidities, current beta blocker use, a baseline low heart rate, and those in whom neuraxial technique resulted in high sensory level.[1] Most pregnant patients fall into the above category, have some of the aforementioned risk factors, and receive neuraxial anesthetic at the time of delivery.

Etiology and Pathophysiology

Cardiovascular effects by the sympathetic nervous system include heart rate acceleration, increased ventricular contractility, reduced venous capacitance, and peripheral vasoconstriction. The parasympathetic nervous system, in turn, affects the cardiovascular system by slowing the heart rate through vagal innervation.[2] The pathophysiology of bradycardia after administration of neuraxial anesthetic is currently not fully understood. The increased susceptibility for hypotensive events following neuraxial sympathetic blocks has been reportedly a result of gestation-induced cardiovascular and mechanical alternations in patient hemodynamics.[2] It is well documented that administration of neuraxial anesthetic causes arterial and venous dilation and leads to decreased systemic vascular resistance with a reduction in preload and afterload.[2] High levels of spinal distribution may cause bradycardia and a decrease of stroke volume by blocking/inhibiting cardiac accelerating sympathetic fibers (T1-T4). Furthermore, the Bezold-Jarisch reflex has been suggested as an additional pathway leading to bradycardia and hypotension after neuraxial administration.[3] This cardio-inhibitory reflex is defined by sudden profound bradycardia, vasodilation, and hypotension from stimulation of cardiac stretch receptors, leading to symptoms of dizziness, near loss of consciousness, or cardiovascular collapse. Nausea and vomiting are also common symptoms in pregnant women in labor, often indicating symptoms of maternal hypotension and/or bradycardia. Such maternal hypotension and/or bradycardia may negatively affect the well-being of the fetus via decreased utero-placental flow, resulting in fetal acidemia.

Several additional etiologies for bradycardia in the setting of neuraxial administration have been described in the literature. Accidental dural puncture during epidural placement is one such etiology. Another one is the administration of IV magnesium, which is given to pregnant women with pre-eclampsia and/or for neuroprotection of the fetus. It causes bradycardia by decreasing sinus node, prolonging AV conduction time, and increasing AV node refractoriness, as well as inhibiting the release

of catecholamines.[4] Relative bradycardia may also occur in several conditions associated with elevated levels of proinflammatory cytokines, including acute viral hepatitis (up to 25% of cases), coronavirus, and intracellular gram-negative pathogens.[4]

Interestingly, studies have demonstrated that the third-trimester heart rate is significantly lower in women with preeclampsia than in healthy control women.[4] Relative sinus bradycardia (mean 55 bpm) has also been associated with delayed post-partum preeclampsia compared to healthy women on a similar post-partum day (mean 84 bpm).[5]

Treatment Options

Though some level of bradycardia is usually well tolerated, asystole and high-degree heart blocks can occur in the most severe cases. Specific management of bradycardia depends on the severity, presence of signs and symptoms, and the most likely etiology at the time of diagnosis. For example, mild bradycardia (40-60 bpm) may not require aggressive treatment, whereas more severe bradycardia (< 40 bpm), especially associated with hypotension, will require intervention to prevent hemodynamic decompensation and fetal compromise.

The initial treatment of mild bradycardia in a pregnant patient with a recent neuraxial block is IV ephedrine, in 10 mg boluses, repeated as needed (UpToDate). Even though IV glycopyrrolate does not cross the placenta, intravenous ephedrine remains the agent of choice in the initial pharmacologic management of hypotension and bradycardia due to high neuraxial administration in a pregnant patient (Tong 1992). Additionally, treatment with a fluid bolus in those patients without overt heart failure symptoms is recommended (500-1000mL). If the bradycardia is not improved or worsens, additional available medications include atropine IV, glycopyrrolate IV (may interfere with uterine contractility), epinephrine IV, and transcutaneous or transvenous pacing. Since neither ephedrine nor norepinephrine (noradrenaline) or phenylephrine is associated with worse fetal outcomes, the administration of any specific medication should be considered on a case-by-case basis.[2] The goal is to avoid reaching maternal asystole, at which point ACLS resuscitation is required. If at any point the fetal tracing becomes non-reassuring, a discussion with the obstetrical team is prudent to alter mode of fetal delivery expeditiously. For those patients that become unresponsive, endotracheal intubation and/or ACLS may be indicated. Current literature supports the use and efficacy of *low-dose* spinal anesthesia, timing and solutions for adequate fluid therapy, and various vasopressor regimens.[2]

Educational Rationale: Identify and manage signs, symptoms, and sequelae of severe bradycardia after administration of neuraxial anesthesia in a pregnant patient.

Target Audiences: OB nursing, Obstetricians, Anesthesiology personnel, OR personnel, medical and nursing students.

Learning Objectives: As per Accreditation Council for Graduate Medical Education (ACGME) Core Competencies
Upon completion of this simulation (including the debrief), learners will be able to:

- *Medical knowledge*: Identify signs and symptoms of ensuing bradycardia in a patient with recent placement of neuraxial anesthetic. Treat bradycardia (and any associated hypotension) effectively and expeditiously. Utilize appropriate monitors and prepare for any hemodynamic decompensation.
- *Patient care*: Effectively recognize bradycardia after neuraxial placement. Call for help early, identify the most likely etiology, and provide early treatment to prevent further hemodynamic decompensation of the fetus and the mother.
- *Practice-based learning and improvement*: Identify the location of the emergency equipment and medications. Familiarize oneself with local and national guidelines for the management of bradycardia in pregnant patients.
- *Interpersonal and communication skills*: Practice team dynamics. closed-loop communication, calling for help early, and delegating/assigning roles in a perioperative urgent or emergent setting.
- *Professionalism*: Demonstrate professionalism and respect for other team members while managing an urgent or emergent situation. Validate and recognize the difficulty and stress the situation creates.
- *Systems-based practice*: Review activating additional help in a setting of perioperative urgency or emergency. Discuss local policies and procedures for the treatment of bradycardia in a pregnant patient, access to emergency carts and medications, as well as activating numerous teams (Ob, Anesthesia, NICU, blood bank, cardiology, or cardiothoracic anesthesiology).

Questions to ask after the scenario:

1. How do you think this scenario went? What do you think went well during the simulation (provide specific examples)? What do you think the team could improve on?
2. Can you identify any limitations or barriers in the team's ability to meet specified learning objectives?
3. What additional differential diagnoses for developing bradycardia could be considered in this scenario?
4. Discuss treatment options for developing bradycardia, dependent on the etiology and severity of the ensuing problem.

Assessment Instruments:

1. Learner Knowledge Assessment form (Appendix1).
2. Simulation Activity Evaluation form (Appendix 2).

Equipment Needed and Set-up:

- Epidural, spinal, and/or combined epidural and spinal kits
- Neuraxial medications
- Monitors: 5 lead EKG, NIBP, pulse oximeter, HR monitor, EtCO2 monitor (if appropriate)
- Adult and pediatric code cart
- Anesthesia machine

- Phone
- Defibrillator / Defibrillator Pads / EKG pads with the ability to pace transcutaneously
- Airway management equipment
- Mannequin
- Access to a 12-lead ECG
- Access to an arterial line kit
- Access to a central line kit
- IV set, IV fluids
- IV medications

Simulation Scenario Set-up:

Case
23 year old 39-week gestation G1 patient, who is a marathon runner, with a past medical history significant for intermittent chronic low back pain after an MVA in childhood, presents to the labor and delivery floor in active labor. She denies any problems during this pregnancy, allergies, or recent illnesses. She takes prenatal vitamins daily and acetaminophen as needed for back pain. After a pre-operative evaluation, an 18G peripheral IV and a CSE block are placed uneventfully, with resultant successful pain relief. Patient-controlled epidural infusion in progress.

Initial exam: HR= 64 bpm, BP=128/68, RR=18, O2 saturations 99% on room air. First vaginal exam: 4 cm dilated, 50% effaced, with a suspected fetal presentation in occipito-posterior (OP) position. FHM: reassuring tracing with normal variability in heart rate.

You are called back to the room within 20 minutes of CSE placement. The patient is now bradycardic and complaining of feeling faint, dizzy, and fatigued.

Labs: WBC 6.1 $x10^9$/L, Hg 12 g/dL, Plt 220 $x10^9$/L, BMP, and coagulation studies within normal limits.

Simulation Pre-Brief

- Orient the learners to the simulation environment. They should become familiar with all equipment in the simulation lab, how to call for help, and what physiologic functions can be replicated during the scenario.
- Read the scenario and instruct team members on their roles during the simulation.
- Review starting clinical setting – pregnant patient in the labor room, s/p recent CSE, now with mild bradycardia feeling dizzy and unwell.
- The learners take their places and the simulation scenario starts.

Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in L&D room, 20 min after an uneventful CSE placement	The patient reports improved labor pain scores. Feels dizzy, nauseated, and fatigued. HR: 50 bpm BP: 89/60mm Hg SpO_2: 99% on room air RR 20/min Temp: 36.6^0C FHR: reassuring tracing, with normal variability	1. L&D nurse notices changes in patient status: □ Calls the OB and Anesthesiology teams □ Lays the patient supine, with left uterine displacement □ Increases NIBP cycling to every 3 minutes □ Connects patient to full monitors □ Administers 100% O2 via non-rebreather mask to the patient □ Ensures fetal tracing is captured 2. Anesthesiology team:			

		□ Places the patient into the Trendelenburg position □ IV fluids opened to gravity □ Administer IV 10-15 mg ephedrine □ Anesthetic level checked: found to have decreased motor in legs bilaterally, sensory level to T10			
10 minutes elapses, patient continues to feel nauseated despite medical interventions	Patient continues to feel lightheaded and fatigued. Emesis x 1. S/p 500 mL fluid bolus, 10mg ephedrine x 2-3 HR: 48 bpm BP: 92/66mm Hg SpO_2: 99% on room air RR 22/min Temp: 36.6^0C FHR: reassuring tracing, with normal variability	1. Ob team: □ Repeat vaginal exam: 80% effaced, 6cm dilated, OP fetal presentation confirmed 2. Anesthesiology team: □ Patient remains in Trendelenburg position with left uterine displacement □ Repeat doses of ephedrine yielded minimal increase in HR, with slightly better increase in BP □ Large second bore IV placed □ 12 lead EKG requested			
Non-reassuring fetal heart tracing noted, with minimal variability and occasional decelerations	Patient continues to feel dizzy and nauseated, starts to complain of difficulty breathing. HR: 44 bpm, sinus bradycardia on 12 lead EKG, without any other abnormalities BP: 90/62 mm Hg RR: 28/min	1. Anesthesiology team: □ Minimal improvement in patient's symptoms or vital signs 2. OB team at bedside: □ OR team informed to prepare for emergency Cesarean delivery due to non-reassuring fetal tracing □ Pediatric team informed □ Family is updated 3. Anesthesiology team: □ Calls for additional help □ Emergency medications to prep: epinephrine,			

		propofol, etomidate, succinylcholine, fentanyl - Discontinue continuous epidural infusion - Administer 10-20 ml, in increments of 3% preservative-free chloroprocraine HCl epidurally to achieve surgical analgesia - Administers additional 10 mg x2 ephedrine IV, evaluate the need for atropine IV or glycopyrrolate IV or epinephrine IV - Transfers the patient to the OR with OB team, fully monitored, on 100% O2 via non-rebreather mask - Request OR staff to check T&C with 2 units of PRBC to be sent to the OR as soon as available - Check labs, and treat any electrolyte abnormalities, including hypokalemia, acid-base abnormalities			
Patient in OR, preparation for cesarean delivery due to continued non-reassuring fetal heart tracing	Supine (with left uterine displacement), sleepy but oriented, yet intermittently vomiting. Full surgical anesthesia to the level of T6 dermatome achieved. HR 32 bpm BP 106/70 mmHg SpO_2 94% on 10 L/min O2 via non-rebreather Resp 22 /min Temp 36.9ºC	1. Anesthesiology team to prepare and plan for potential sequelae of severe bradycardia: - Call for additional help - Consider the placement of invasive arterial line monitoring - Manage bradycardia, with medications: ephedrine IV, atropine IV, glycopyrrolate IV, epinephrine IV - Request code cart to be brought into the room, including defibrillator - Place defibrillator pads with needed EKGs on the patient, sync ON - If transcutaneous pacing is selected, start at 80			

		bpm; begin at 80 mA and increase by 10 mA until capture/pulses are noted, then increase output by an additional 10 mA. - If transvenous pacing is chosen, central line access must be obtained; initial setting includes 80 bpm, set A and V outputs to start at 20mA, then adjust down while maintaining capture.			
Delivery of fetus within 3 minutes of arrival to the OR. NICU personnel at bedside with newborn. Transferred to the NICU for continued care.	Continues to be fatigued but oriented. HR 80 bpm, paced rhythm BP 110/82 mmHg SpO_2 98% on 10 L/min O2 via non-rebreather Resp 20 /min Temp 36.9ºC	1. Anesthesiology Team: - Initiate transcutaneous pacing, SYNC ON, 80 bpm at 100 mA - Consider placing arterial and central lines - Consider initiating epinephrine drip via central line - Consider placing TTE or TEE probe to assess cardiac function and volume status - Be aware of surgical maneuvers, like externalization of the uterus, resulting in increase vagal tone and/or potential arrhythmias 2. Ob Team: - Update family - Initiate patient disposition plans in discussions with anesthesiology team - Consider cardiology consult post-operatively			

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Appendix 1

Learner Knowledge Assessment
Labor and Delivery Multidisciplinary Team Simulation

Name of Simulation: **Bradycardia after Neuraxial Anesthesia in a Pregnant Patient** Date: _____

OB Nursing Anes

Each item has two components. The "Before the simulation" column (left side) examines your perspective at the beginning of the simulation. The "End of Simulation" column (right side) is to evaluate your perspective at the completion of the simulation.

1. How would you rate your knowledge of risk factors for development of bradycardia shortly after neuraxial anesthetic placement in a pregnant patient?

BEFORE THE SIMULATION	END OF SIMULATION
1 2 3 4 5 6 7 Little/none Knowledgeable	1 2 3 4 5 6 7 Little/none Knowledgeable

2. How would you rate your knowledge of differential diagnoses of bradycardia in a pregnant patient?

BEFORE THE SIMULATION	END OF SIMULATION
1 2 3 4 5 6 7 Little/none Knowledgeable	1 2 3 4 5 6 7 Little/none Knowledgeable

3. How would you rate your knowledge of signs and symptoms of ensuing bradycardia?

BEFORE THE SIMULATION	END OF SIMULATION
1 2 3 4 5 6 7 Little/none Knowledgeable	1 2 3 4 5 6 7 Little/none Knowledgeable

4. How would you rate your knowledge of delivery planning for a pregnant patient with severe bradycardia?

BEFORE THE SIMULATION	END OF SIMULATION
1 2 3 4 5 6 7 Little/none Knowledgeable	1 2 3 4 5 6 7 Little/none Knowledgeable

5. How would you rate your overall confidence when confronted with managing severe bradycardia in a pregnant patient intraoperatively?

BEFORE THE SIMULATION	END OF SIMULATION
1 2 3 4 5 6 7 Little/none Knowledgeable	1 2 3 4 5 6 7 Little/none Knowledgeable

Appendix 2

Simulation Activity Evaluation

DATE OF SIMULATION: _____

OCCUPATION: Consultant PG Yr1234 STUDENT NURSE MIDWIFE OTHER

SPECIALTY:_____ YEARS IN PRACTICE: _____

Please rate the following aspects of this training program using the scale listed below:

1 = Poor 2= Suboptimal 3 = Adequate 4 = Good 5 = Excellent

Use "N/A" if you did not experience or otherwise cannot rate an item

INTRODUCTORY MATERIALS						
Orientation to the simulator	1	2	3	4	5	N/A
PHYSICAL SPACE						
Realism of the simulator space	1	2	3	4	5	N/A
EQUIPMENT						
Satisfaction with the mannequin	1	2	3	4	5	N/A
SCENARIOS						
Realism of the scenarios	1	2	3	4	5	N/A
Ability of the scenarios to test technical skills	1	2	3	4	5	N/A
Ability of the scenarios to test behavioral skills	1	2	3	4	5	N/A
Overall quality of the debriefings	1	2	3	4	5	N/A
DID YOU FIND THIS USEFUL?						
To improve your clinical practice?	1	2	3	4	5	N/A
To improve your teamwork skills?	1	2	3	4	5	N/A
To improve your VERBAL communication?	1	2	3	4	5	N/A
To improve your NONVERBAL communication?	1	2	3	4	5	N/A
FACULTY						
Quality of instructors	1	2	3	4	5	N/A
Simulation as a teaching method	1	2	3	4	5	N/A

COMMENTS/SUGGESTIONS: