SOAP
Society for Obstetric Anesthesia and Perinatology

Simulation Patient Design (March 2024)
Case of Fetal Bradycardia during Intrauterine Fetal Intervention: Laser photocoagulation for twin-twin transfusion syndrome

Author(s): Sapna Ravindranath, MBBS, MD; Indiana University School of Medicine
Editors: Kokila Thenuwara, MD, MME MHDCS, Jessica Sheeran, MD

Introduction

The three main categories of fetal interventions include minimally invasive fetal procedures, open mid-gestation fetal surgeries, and ex utero intrapartum treatment (EXIT) procedures. Fetal interventions carry significant risks to both the mother and her fetus(es).

Twin-twin transfusion syndrome (TTTS) occurs in 10% of monochorionic, diamniotic twin pregnancies, due to abnormal arterio-venous placental connections resulting in oligohydramnios and intrauterine growth restriction of the donor twin while the recipient twin develops polyhydramnios and heart failure. If untreated, severe TTTS has <5% survival rate. The diagnosis of TTTS depends on the finding of polyhydramnios/oligohydramnios sequence in a monochorionic, diamniotic pregnancy. In TTTS, oligohydramnios is defined as a deepest vertical pocket (DVP) of 2 cm or less in the donor sac, while polyhydramnios is defined as DVP of 8 cm or more in the recipient sac. The staging system for TTTS was proposed by Quintero et al[1] in 1999. Options for treatment include expectant management, laser ablation, repeated amnioreduction, septostomy of the inter-twin dividing membrane, selective reduction, and termination of the entire pregnancy. Typically, Selective Fetoscopic Laser Photocoagulation (SFLP) of the abnormal placental connections is usually performed between 16-26 weeks of gestation with ultrasound guidance and direct visualization through fetoscope.[2] SFLP is an example of minimally invasive fetal surgery. Anesthesia options include neuraxial anesthesia or monitored anesthesia care with local anesthesia based on institutional preferences.[3]

Fetal bradycardia (FHR <100 beats per minute) is more common during open fetal surgery and Ex-utero Intrapartum Therapy (EXIT) than minimally invasive procedures. The common causes of fetal bradycardia include mechanical compression or kinking of the umbilical cord, uterine contractions, placental separation, maternal hypotension, umbilical artery vasospasm, anemia, or hypoxemia.[2] Less common causes include fetal hypovolemia, hypothermia, and anemia. The surgical team must be notified, and the possible etiology of fetal bradycardia rapidly identified. If fetal bradycardia occurs, the anesthesiologist should increase maternal inspired oxygen, administer vasoactive drugs and intravenous fluids to ensure appropriate maternal blood pressure and heart rate, administer additional tocolytic agents in the presence of uterine contractions, and rule out aortocaval compression as a cause of maternal hypotension. The surgeons should rule out mechanical compression of the umbilical cord by stopping the procedure, repositioning the fetus and increasing the amniotic fluid volume.[4] Placental abruption must also be ruled out. If these initial measures are unsuccessful, fetal resuscitation medications (eg, epinephrine, atropine) should be administered to the fetus via the intramuscular route. Depending on the gestational age of the fetus, emergency cesarean delivery needs to be considered.

The aim of this simulation is to address the anesthetic considerations involved in minimally invasive fetal procedures as well as the management of fetal bradycardia.

Educational Rationale: To teach team skills in managing fetal bradycardia during minimally invasive fetal interventions.

Target Audiences: Nursing, OB, Anesthesiology, OR personnel

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: Recognize fetal bradycardia during minimally invasive fetal intervention procedure and describe the treatment.

Patient care: List the risk factors that contribute to fetal bradycardia during fetal procedures and discuss management steps.

Practice-based learning and improvement: Identify the setting, equipment, and medications necessary to manage an obstetric patient with fetal bradycardia during fetal intervention procedure.

Interpersonal and communication skills: Assign roles such as a team leader who will coordinate the team to provide optimal care to the patient and maintain ongoing communication about the evolution of the clinical situation among the providers.

Professionalism: Demonstrate mutual respect for expertise of other team members.

Systems-based practice: Ensure all personnel, resuscitation equipment, medications, and protocols are readily identifiable and available in delivery locations including airway management, anesthesia induction/emergency medications, and vascular access. Include identification of barriers within the hospital system to carrying out fetal resuscitation.

Questions to ask after the scenario:

1. What are common causes of fetal bradycardia during fetal procedures?
2. How was the response to the crisis managed?
3. Did each team member have a well-defined role?
4. Were the next steps for management clearly outlined by the care team?
5. Was all necessary equipment available?
6. Were there any barriers or system issues identified when caring for the patient?
7. What is the treatment for fetal bradycardia?
8. What factors would lead you to intervene with this patient's airway?
9. What factors might influence the decision for an emergent cesarean delivery?

Assessment Instruments:

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

Equipment Needed and Set-up:

In-situ set-up

1. Mannequin set-up in OR using standard fetal laser ablation procedure set-up
2. One 18G IV setup with fluids attached and multiple access ports on the line
3. Standard monitors (e.g. EKG, NIBP, SpO2, ultrasonography)
4. Fetal rhythm strips on monitor
4. Laser equipment and laser safety glasses

Simulation Scenario Set-up:

The case

Mrs. Amy Fairbanks is a 31-year-old G2P1 with monochorionic, diamniotic twins at 25 weeks gestational age. She presents to the Labor and Delivery floor for a scheduled elective fetal laser ablation procedure. Her history is significant for morbid obesity with a BMI of 32. NKDA. Airway exam: Mallampati class 1, full ROM neck, normal mouth opening and thyromental distance. The rest of her pre-anesthesia evaluation is unremarkable.

Simulation Pre-brief

- Read the scenario and instruct team members on their role during the simulation.
- The learners take their places.
- Simulation driver plays the patient.
- Confederate plays the patient's partner.

Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in OR ready for SFLP procedure Combined spinal-epidural anesthesia was performed for surgical anesthesia	Patient sedated with remifentanil infusion (mild sedation) HR 90 bpm BP 112/64 mm Hg SpO_2 99% (oxygen through nasal cannula at 2 lpm) Resp 16/min Temp 37.1^{0}C	1. MFM confirms placental site and fetal heart rate using doppler ultrasonography 2. Checks incisional site for pain 3. Proceeds with time out 4. Surgery starts 5. Connects amnioinfusion tubing to the fetoscope			
Fetal Bradycardia FHR to 90's	Lab results from initial presentation (2 h ago): Hb 12.4 g/dL Plt 195 x10^9/L	1. OB team stops surgical manipulation 2. Continuous ultrasound visualization of fetal cardiac activity and rate 3. Anesthesiologist recognizes the situation and communicates with surgeon			
Fetal heart rate improves gradually to normal FHR to 140's	Supine (with left uterine displacement), easily arousable and oriented HR 121 bpm BP 96/57 mm Hg SpO_2 97% (air) Resp 15/min Temp 36.9^{0}C	1. Anesthesia team increases phenylephrine infusion rate 2. Crystalloid bolus: 250 ml LR 3. Surgery restarted			
Second episode of fetal bradycardia FHR again drops to 90's	HR 91 bpm BP 126/67 mm Hg SpO_2 97% (air) Resp 15/min Temp 36.9^{0}C	1. IM atropine administered by surgeon 2. Preparation for emergency cesarean delivery 3. Additional nursing assistance called			

OB suspects placental abruption	Patient looks pale	1. Support person escorted out of OR 2. Discontinue remifentanil sedation and inform patient about the need of emergent cesarean delivery 3. Administer oxygen 10 L/min via non-rebreather facemask			
C-section started and in-progress Patient becomes hemodynamically unstable QBL 800 ml	HR 122 bpm BP 88/55 mm Hg SpO_2 97% (oxygen) Resp 20/min Temp 36.8^{0}C	1. Anesthesiologist confirms sensory level to T4. Lidocaine and chloroprocaine available to bolus epidural if needed. 2. Fluids and Vasopressors as indicated 3. Call for 2 units of crossmatched PRBCs 4. CBC and coagulation profile immediately sent			
Live infants delivered and handed off to pediatric team. Infants noted to be minimally active. Apgars 4,5 at 1 and 5 minutes respectively QBL 1100 ml	Patient is worried about her babies HR 98 bpm BP 108/58 mm Hg SpO_2 99% Temp 36.6^{0}C	1. Reassure the patient 2. Administer oxytocin after delivery of the second twin 3. Uterine tone is great per OB 4. Active warming 5. 1 gram of tranexamic acid administered			
Incision closed	Vital signs stabilize HR 92 bpm BP 114/68 mm Hg SpO_2 98% (room air) Temp 36.9^0 C Repeat lab results (from earlier in OR): Hb 9.8 g/dL Plt 155 x10^9/L INR 1.1 Fib 370 mg/dL	1. Surgery completed. 2. OB and anesthesia teams agree on holding off transfusion. 3. Epidural catheter removed after morphine administration 4. Patient transferred to PACU 5. Family updated			

Appendix 1

Learner Knowledge Assessment
Labor and Delivery Multidisciplinary Team Simulation

Name of simulation: _____________ 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 fetal 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

2. How would you rate your knowledge of differential diagnosis of fetal 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

3. How would you rate your knowledge of treatment of fetal bradycardia during laser ablation for TTTS?

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 anesthetic management for laser ablation in TTTS?

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 fetal bradycardia during fetal surgery?

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 Yr 1 2 3 4 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:

References:

1. Quintero RA, Morales WJ, Allen MH, Bornick PW, Johnson PK, Kruger RM. Staging of twin-twin transfusion syndrome. J Perinatol. 1999;19:550–5.

2. Chatterjee, Debnath MD, FAAP*; Arendt, Katherine W. MD†; Moldenhauer, Julie S. MD‡; Olutoye, Olutoyin A. MD, MSc§; Parikh, Jagroop Mavi MD‖; Tran, Kha M. MD¶; Zaretsky, Michael V. MD#; Zhou, Jie MD, MS, MBA**; Rollins, Mark D. MD, PhD†. Anesthesia for Maternal–Fetal Interventions: A Consensus Statement From the American Society of Anesthesiologists Committees on Obstetric and Pediatric Anesthesiology and the North American Fetal Therapy Network. Anesthesia & Analgesia 132(4):p 1164-1173, April 2021. | DOI: 10.1213/ANE.0000000000005177

3. Ferschl MB, Feiner J, Vu L, Smith D, Rollins MD. A Comparison of Spinal Anesthesia Versus Monitored Anesthesia Care With Local Anesthesia in Minimally Invasive Fetal Surgery. Anesth Analg. 2020;130(2):409-415.

4. Ferschl MB, Rollins MD, Chatterjee D. Error traps in anesthesia for fetal interventions. Paediatr Anaesth. 2021 Mar;31(3):275-281. doi: 10.1111/pan.14120. Epub 2021 Feb 11. PMID: 33394561.

5. Hoagland M, Chatterjee D. Anesthesia for Fetal Interventions - An Update. Adv Anesth. 2021;39:269-29.