Simulation Patient Design (June 2023)

Case of Unknown Placement of Subdural Catheter

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Introduction

Subdural injections and subdural catheter placement are rare but known complications associated with neuraxial procedures.[1,5] The subdural space is located between the dura matter and the arachnoid interface. It can be accessed unintentionally during epidural placement leading to variable clinical presentations.[6] Classic risk factors for subdural injection include history of back surgery, recent lumbar puncture, catheterization following previous subdural injection, epidural needle rotation before catheter insertion, and difficult block placement.[1,2,8]

Local anesthetic injection into the subdural space often presents with heterogenous clinical features making the diagnosis of a subdural catheter or injection difficult to recognize. Subdural blocks are often characterized by slow onset, higher than expected sensory block for volume injected, and inadequate or patchy sensory block.[1,4,6,8] Subdural injections tend to settle in the larger, posterior column and around the dorsal root ganglia, thus often sparing the motor and sympathetic fibers located ventrally, though this is variable (Appendix 3, Figure 1).[1,8] Patient presentation may include a higher than expected sensory block for the amount of drug administered to completely inadequate or absent sensory block, minimal motor block, and hypotension that is less profound than a spinal dose but more than expected with an epidural dose.[1,3,4,5,6,8]

The subdural space is a potential space that may be unequal bilaterally. The subdural space can also be a relatively short space or can extend the whole length of the vertebral column into the cranial cavity which may account for some of the variability in presentation. Extension of local anesthetic into the brainstem can lead to a high spinal block which can be detrimental, causing slow onset dyspnea, loss of consciousness, severe cardiovascular depression and cardiac arrest.[1,6,7,8,9] It can cause Horner's syndrome, facial flushing, and may be mistaken for a stroke.[9] Subdural catheters often evade the initial signs of a positive test dose, leading to challenging, delayed, or even missed diagnosis of the subdural catheter.

The incidence of unintentional subdural catheterization is 0.02-0.82% clinically, but this may be an underestimate.[3,5,6,8] Definitive imaging is the gold standard to diagnosis a subdural catheter but that is not feasible on labor and delivery. Patients with suspected or accidental subdural catheters should be monitored closely for high sensory levels and provided cardiovascular and respiratory support as needed. Since subdural catheters do not provide predictable analgesia, the catheter should be removed and a new epidural catheter placed in another lumbar interspace. In obstetric anesthesia, greater awareness of subdural blocks and their clinical signs will hopefully bring about more vigilance, higher level of suspicion, and earlier recognition and treatment when analgesic blocks present atypically.

Educational Rationale: To teach team skills in recognizing and managing unintentional subdural catheter placement in pregnant patients.
Target Audiences: Anesthesiologists, anesthesiology residents, CRNAs, L&D nurses, midwives, OB providers, medical students and OR staff.
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*****:** Describe clinical presentations that would increase suspicion of a subdural catheter. Recognize the variable clinical presentations of a subdural block. Understand the differential diagnosis. Understand the risks and complications associated with a subdural catheter injection. Treat and manage the patient when a subdural catheter and injection is highly suspected.
- ***Patient care*****:** Respond appropriately to unusual neurologic symptoms after an epidural. Evaluate, identify, and manage a patient with a subdural catheter and the impending crisis.
- ***Practice-based learning and improvement*****:** Apply the clinical picture and conflicting evidence to diagnose and guide patient care. Identify the setting, equipment, and medications necessary to manage an obstetric patient with a subdural catheter.
- ***Interpersonal and communication skills*****:** Utilize closed loop communication to safely manage and direct patient care amongst team members. Explain to the patient your clinical suspicion or diagnosis of subdural catheter and management plan.
- ***Professionalism*****:** Maintain a professional and respectful attitude to all team members during a stressful situation.
- ***Systems-based practice*****:** Anticipate potential hemodynamic, respiratory, and neurologic problems and ensure appropriate rescue airway devices and medications are available to ensure patient safety.

Questions to ask after the scenario:

1. What is the differential diagnosis for slow onset epidural/non-functioning epidural/ patchy epidural?
2. What were the signs and symptoms of the catheter being subdural in this patient?
3. How was the management of the subdural catheter?
4. Were there any barriers in diagnosing the subdural catheter?
5. Were there opportunities for improvement(s) identified during the scenario?

Assessment Instruments:

1. Learner Knowledge Assessment form (Appendix 1)
2. Simulation Activity Evaluation form (Appendix 2)
3. Figure 1 of subdural space (Appendix 3)

Equipment Needed and Set-up:
In-situ set-up
L&D Suite:

- Gravid mannequin in the Labor and Delivery room
- Standard L&D monitors: pulse oximeter, Non-Invasive BP cuff and EKG leads available
- Tocodynamometer, fetal heart rate monitor

- One 18 g PIV in place with IV bag (Lactated Ringer or Plasmalyte) connected
- L&D room with wall O2 and suction, non-rebreather face mask

Simulation Scenario Set-up:

The case

Patient is a 31-year-old G1P0 at 39w0d who presents in labor with spontaneous rupture of membranes. Her past medical history is significant for a BMI of 35. Initial admission vitals with BP=118/68 mmHg, HR= 97 bpm, and oxygen saturation=98% on room air. Initial cervical exam by obstetric resident: 4/70/-3. Admission labs are sent and patient is admitted to L&D. The patient requested a labor epidural for analgesia upon admission. Anesthesia placed the epidural without incident at L3/4 (loss of resistance at 4 cm and catheter taped at 9 cm at the skin). The epidural had negative aspiration and test dose, and the anesthesia team bloused the epidural with 10mL 0.2% ropivacaine. The catheter was just connected to the epidural pump at 8 ml/h.

Simulation Pre-brief

- Read the scenario and instruct team members on their role during the simulation
- The learners take their places
- The L&D nurse is bedside with the patient. Other members of the OB, anesthesia and OR team are available if called but should exit the immediate space until they are called.
- Need confederate available to participate as part of neurology team during the stroke code.

Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in L&D bed in left uterine displacement position. 15 min after epidural placement and pain score unchanged (6/10) L&D nurses calls OB anesthesia to evaluate the patient	Supine with left uterine displacement, awake and oriented, breathing through contractions every 2-3 min 18g IV in place with IVF running open BP 98/83 mmHg HR 99 bpm SpO_2 97% (air) Resp 25/min Temp 37.1^oC FHR 140, cat I CTX q2-3min	L&D nurse calls back OB anesthesia to evaluate pain and epidural ☐ Anesthesia evaluates pt and assess level of block ➔ Level is <T10, inadequate ☐ Anesthesia administers additional 10 cc 0.125% bupivacaine bolus ☐ Assesses pt vitals, FHR, pain- patient reports some pain relief but sensory block remains patchy despite boluses			

Jump forward in time 30 minutes: 30 min after epidural bolus Patient complains of L abdominal contraction pain, weakness in R arm and "feeling funny"	Patient lying in bed, noted to be in pain, have R sided eyelid drooping BP 78/62 mmHg HR 105 bpm SpO2 94% (air) RR 27/ min FHR 125, cat II variable decels CTX q2-3min	☐ L&D nurse notes facial droop ☐ L&D nurse calls OB and anesthesia to evaluate ☐ OB or anes call Code stroke OB Anesthesia evaluates patient hemodynamics, neurologic status and exam, epidural block level and aspirates epidural to rule out intrathecal catheter. ☐ Evaluates and appropriately treats hemodynamics with fluids and vasopressor ☐ Negative aspiration of epidural catheter ☐ Neuro exam performed: A&Ox3. R sided ptosis and miosis noted. Motor strength intact. ☐ Sensory exam performed: Patient with patchy block: decreased sensation to light touch/cold from T2-L3 on the R and T10-L3 on the L, with an L lower abdominal window.			
Patient reports feeling short of breath. Stroke team arrives	Patient lying in bed, looks distressed and is tachypneic BP 105/72 mmHg HR 110 bpm SpO_2 92% (room air) Resp 29/min FHR 125, cat II variable decels CTX q2-3min Stroke code ongoing with neurology evaluation and asking if the patient can go to CT. If team agrees, pt sits up and epidural infusion is turned off to get patient ready for	☐ Place nonrebreather oxygen mask on patient. Additional airway supplies, pressors and drugs brought into room. ☐ Anesthesia states concern for subdural catheter ☐ Epidural infusion turned off ☐ Sit patient up in bed ☐ Disclose to patient concern epidural catheter is subdural resulting in the symptoms. ☐ Discuss removing catheter with patient who is amenable			

	transport. While waiting, symptoms improve. --- If Subdural catheter is <u>not</u> recognized: Vitals worsen BP 76/50 mmHg HR 130 bpm SpO_2 88% (room air) Resp 40/min FHR decels to 80 bpm CTX q2-3min ➔ Progressive dyspnea, altered mental status	☐ Neuraxial catheter removed --- If Subdural catheter is <u>not</u> recognized: PCEA infusion continues with patient or clinician boluses for pain, ☐ Call for help ☐ Intrauterine resuscitation as necessary ☐ Fluid and vasopressors as necessary ☐ Airway management as necessary ☐ Neurology team can suggest turning off epidural infusion if this was not done prior			
Patient reports feeling better after sitting up.	Once pt sitting up, epidural turned off/removed: Patient less anxious or tachypneic BP 119/75 mmHg HR 95 bpm SpO_2 98% (10L) FHR 140 bpm CTX q2-3min	☐ Code stroke called off ☐ Anesthesia discusses plan to keep patient sitting up with close observation and hemodynamic monitoring with L&D nurse, OB and patient ☐ Close observation of patient until all symptoms resolve with no residual deficits			

Symptoms resolve. Labor progressed to SVE 7/100/0 Patient in pain, requesting epidural replaced	Patient in pain, breathing through contractions BP 121/81 HR 92 SpO2 98% (air)Patient less anxious or tachypneic BP 119/75 HR 95 bpm SpO_2 98% (10L) FHR 140 CTX q2-3min	☐ Anesthesia assesses pt, discusses replacement versus alternative pain options. ➔ Epidural placed at L4/5 LOR @ 4 cm without incidence. Neg test dose. Patient experiences relief No complications			

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 subdural catheter?

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 subdural catheter?

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 subdural catheter?

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 labor analgesia management after a subdural catheter placement?

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 a subdural catheter placement and its clinical presentation?

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:

Appendix 3

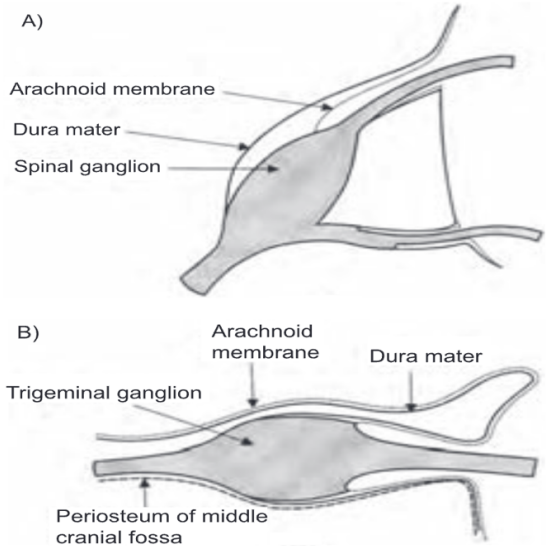

FIGURE 1: Diagram showing extension of subdural space over A) dorsal root ganglion and B) trigeminal ganglion.

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