Simulation Patient Design (November, 2021)

Acute Myocardial Infarction in Pregnancy (Pregnancy-associated Spontaneous Coronary Artery Dissection)

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Introduction: The incidence of pregnancy-associated myocardial infarction (PAMI) has not been firmly established, however a meta-analysis demonstrated an increasing incidence of 1:25,000 which reflects a 3 to 4-fold higher rate of myocardial infarction (MI) compared to non-pregnant, aged-matched women.[1–4] Maternal mortality from MI is twice that of non-pregnant women, and PAMI accounts for 15% of maternal deaths from cardiovascular disease.[5,6] PAMI most often occurs in the first week postpartum, but can also present in the third trimester, through one-year postpartum.[1,7,8] More than 40% of cases are caused by pregnancy-associated spontaneous coronary artery dissection (PA-SCAD) which occurs when an intimal-medial tear of the coronary artery forms an intramural hematoma.[7-10] MI in SCAD reflects an ischemic imbalance not attributed to atherosclerotic, iatrogenic or traumatic causes, or intracoronary thrombus.[11–13]

Etiology: The mechanism for PA-SCAD reflects both hemodynamic and hormonal changes during pregnancy. During late pregnancy, delivery, and early postpartum, large swings in cardiac output and blood volume increase shearing forces on the coronary vasculature. The myocardium is more vulnerable to ischemia during pregnancy due to physiologic anemia combined with an increase in oxygen demand from changes in heart rate, cardiac output and left ventricular thickness. Pregnancy hormones weaken the vascular endothelium of the coronary arteries by impairing collagen synthesis (progesterone), enhancing the hypercoagulable state, and releasing matrix metalloproteinase that weaken the vasa vasorum (estrogen).[9,14,15] Oxytocin increases vascular reactivity to angiotensin II and catecholamines, which may potentiate coronary artery spasm.

Clinical Presentation: PA-SCAD commonly presents with chest pain (75%), shortness of breath (30%), and nausea in women without atherosclerotic risk factors.[3,7,8,15] Risk factors for PA-SCAD include maternal age >30-years (78% occur in women >30-years, and almost half in women >35-years), hypertension, vascular abnormalities such as fibromuscular dysplasia, aneurysms or dissections (40-80%), and inherited connective tissue disease such as Marfan syndrome or Ehlers-Danlos syndrome. [6,8,12,16–19] It is unclear if multiparity or preeclampsia confer a higher risk. The differential for PAMI includes SCAD, aortic dissection, pulmonary embolism, cardiomyopathy (Takotsubo or peripartum), myocarditis, and preeclampsia.

Diagnosis: A clinical diagnosis of PAMI requires abnormal cardiac biomarkers (troponin I, creatine kinase-MB) and EKG changes. Brain natriuretic peptide (BNP) or pro-BNP are often elevated in PA-SCAD due to a high rate of concomitant heart failure. ST depressions must be considered in the clinical context, as they may be associated with non-ischemic changes in cesarean deliveries and oxytocin administration.[20-21] Notably, ST elevations are always abnormal and a common finding in PA-SCAD. Coronary angiography is the gold standard for diagnosis of SCAD.

Maternal Outcomes: Pregnant vs. non-pregnant patients with SCAD are more likely to have severe disease.[9,22] PA-SCAD involves the left anterior descending coronary in 75% of patients, the left main stem in 36%, and multivessel disease in 40%.[7] Given the relative severity of PA-SCAD, 44% of women are affected by heart failure or reduced ejection fraction.[7]

Conservative Management: A study by Hassan et al. demonstrated angiographic healing in 95% of SCAD lesions after 30 days.[23] Thus, if the patient is hemodynamically stable, medical management is appropriate. Conservative treatment with beta blockers (metoprolol or labetalol) and nitrates decrease myocardial oxygen consumption and improve coronary flow, but must be used cautiously to avoid placental hypoperfusion. Anticoagulants in SCAD should be considered, but carry the risk of worsening the hematoma or dissection. Full dose aspirin may be used until 32 weeks gestation, after which the dose should be reduced to 81 mg. If antiplatelet drugs are indicated, clopidogrel is preferred. For therapeutic anticoagulation, heparin is favored over coumadin because it does not cross the placenta. Worsening maternal hemodynamics should prompt evaluation for extension of the dissection or hematoma.

Revascularization: Unstable PA-SCAD requires revascularization. The decision to perform a percutaneous coronary intervention (PCI) should be carefully evaluated due to the elevated risk of procedural failure, iatrogenic dissection and clinical decompensation in pregnancy and postpartum. To reduce the risk of iatrogenic dissection, the radial artery should be avoided.[24] In the event of failed PCI, hemodynamic instability, multivessel involvement, or an anatomically difficult coronary target, a coronary artery bypass graft is indicated.

Delivery: Any patient with PA-SCAD and a viable pregnancy should have a delivery plan. When possible, delivery should be postponed for at least two weeks post-MI to allow for maternal recovery.[25] Mode of delivery should be determined by obstetric and fetal indicators. Antenatal steroids and magnesium must be considered due to high rates of maternal complications. Preparation for maternal cardiac arrest is imperative, and should include plans for mechanical circulatory support and emergency cardiac surgery.

Follow up care: If PCI was pursued with stenting prior to delivery, decisions regarding anticoagulation should be made in conjunction with a cardiologist. A work-up for underlying connective tissue disease should be performed. Patients with PA-SCAD benefit greatly from cardiac rehabilitation and should also be referred to mental health services to treat anxiety, depression, and post-traumatic stress disorder.[26] Reproductive counseling is instrumental, and subsequent pregnancies should be discouraged.

Educational Rationale: To teach anesthesiologists and obstetricians how to evaluate for symptoms of PAMI secondary to SCAD, as well as identify best practices for peripartum monitoring, administration of anesthetic/analgesic drugs, and other specific management concerns.
Target Audiences: Obstetric anesthesiologists, general anesthesiologists, maternal-fetal medicine specialists, obstetricians, L&D nursing
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 the clinical presentation of PA-SCAD, including timing, concurrent symptoms and complications (including iatrogenic)
- *Patient care:* Recognize that PA-SCAD is the most common cause of PAMI, and has a different management algorithm than other causes of MI
- *Practice-based learning and improvement*: Understand that cardiac catheterization in pregnancy is associated with a high failure rate and higher than normal risk of iatrogenic complications
- *Interpersonal and communication skills*: Develop a multidisciplinary plan for delivery in a safe manner and communicate with the team when therapy and management is required
- *Professionalism*: Execute safe care while listening to all team members
- *Systems-based practice*: Develop a clear anesthetic plan for labor and delivery and discuss any system issues involved in the case of an urgent or stat cesarean delivery

Questions to ask after the scenario:

- Did anyone identify themselves as the team leader?
- Did each individual have a well-defined role?
- Did team members communicate effectively?
- Were all the necessary drugs and equipment (including crash cart and defibrillator) readily available?
- Was the medical decision-making clear?
- Were cognitive aids used?

Assessment Instruments:

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

Equipment Needed and Set-up:
<u>L&D</u>
EKG, pulse oximeter, NIBP
Epidural catheter
Crash cart/defibrillator
<u>OR</u>
EKG, pulse oximeter, NIBP, arterial line, central line
Airway equipment - video laryngoscope, ETTs, oral airways, suction
Crash cart/defibrillator with resuscitation drugs

Simulation Scenario Set-up:
Case

38-year-old, G2P1 presents to L&D triage at 36 weeks gestational age complaining of epigastric/substernal chest pain with nausea and shortness of breath that started 4 hours ago after eating dinner. Past medical history includes essential hypertension that is treated with an unknown medication. Her prior pregnancy was an uncomplicated vaginal delivery with an epidural. She has no other medical or surgical history and denies symptoms of labor.

Simulation Pre-brief

- Read the scenario and instruct team members on their roles during the simulation
- One nurse and one OB resident inside the L&D room with the patient
- The learners take their places outside the L&D room

Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient is in OB triage reporting chest pain, nausea + shortness of breath x4 hours	Patient is diaphoretic + in mild distress from chest pain Not contracting HR 95 bpm BP 85/50 mm Hg SpO_2 94% (air) Resp 16/min Temp 37.1^{o}C FHT 110/min	L&D triage nurse performs initial patient evaluation and examination □ Calls the OB to assess patient □ Informs the anesthesiology team □ Places 18G IV + sends labs (CBC, CMP, troponin, CK-MB fraction, BNP/proBNP) □ Obtains EKG OB/Anesthesiology □ Avoid excessive fluid administration until further studies available □ Early cardiology consult for symptoms, based on CVD screening algorithm			
Cardiologist at bedside	Lab results: Hgb 11.2 g/dL Plts 130 x10^{9}/L INR 1.0 Troponin 2 ng/ml CK-MB 25 IU/L BNP 400 pg/mL EKG: ST elevations (leads V1-V4)	Cardiology consult □ Anticipate cath lab OB/nursing □ FHTs pre/post or intra-procedure □ Emergency delivery plan Anesthesiology □ Supportive care			

		□ Vasopressor support as needed □ Avoid excessive IV fluid			
Coronary angiogram demonstrates spontaneous coronary artery dissection of the mid-LAD and EF 30% No stents placed Balloon angioplasty performed	Supine (with LUD), awake + oriented HR 101 bpm BP 106/67 mm Hg SpO_2 94% Resp 15/min Temp 36.9^{o}C FHTs 120s/min	□ Start aspirin therapy (alone) since she is close to delivery (dual antiplatelet therapy will preclude neuraxial anesthesia) □ Continue labetalol for reduced myocardial stress + oxygen demand Multidisciplinary discussion regarding delivery planning □ Antenatal steroids (since <37 weeks gestation)			
<u>Advance simulation time-line to 39 weeks</u>: Patient remains in CCU until IOL at 39 weeks Tocometry shows low frequency contractions Cardiac biomarkers down-trending	Lab results: Hb 10.8 g/dL Plts 105 x10^{9}/L INR 1.1 Troponin 0.5 ng/mL CK-MB 5 IU/L BNP 200 pg/mL Repeat TTE: EF 40% with hypokinesis of the anterior wall	□ Place epidural to reduce the sympathetic response to labor □ Send repeat labs including T&S □ Place 2 large bore PIVs (central line kit available) □ Place arterial line □ Prepare OR (in case of worsening dissection) □ Cardiology, Cardiothoracic surgery + circulatory support teams available			

Assisted 2nd stage of labor (to avoid Valsalva) QBL 800 mL (with no further bleeding)	Assisted delivery (forceps) Patient appears pale + reports new chest pain 20 min postpartum HR 122 bpm BP 75/55 mm Hg SpO_2 92% (air) Resp 20/min Temp 36.8°C	Concern for propagation of dissection □ Avoid methylergonovine (or other drugs that will increase myocardial oxygen demand) □ Repeat EKG, Troponin and CK-MB □ Alert cath lab for repeat angiography			
Coronary angiography shows propagation of dissection through LAD and new dissection of LCx Cardiac biomarkers rising	HR 138 bpm BP 70/45 mm Hg SpO_2 92% Temp 36.6°C Repeat EKG: ST elevations (V1-V6) Repeat lab results (from earlier in OR): Hb 9.2 g/dL Plt 100 $x10^9$/L INR 1.12 Troponin 1.5 ng/mL CK-MB 20 IU/L	Plan to transfer the patient to OR for cardiothoracic surgery for failed PCI requiring urgent CABG □ Consult cardiac anesthesiology for OR			
Post-op	HR 122 bpm BP 95/48 mm Hg SpO_2 96% (intubated)	□ Patient transferred to ICU (intubated) □ Family updated □ Team debrief			

Appendix 1

Obstetric Interdisciplinary Team Simulation

Name of simulation:
Date:

Anesthesiology Obstetricians Nursing

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 ability to recognize pregnancy-associated MI?

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

2. How would you rate your knowledge of pregnancy-associated spontaneous coronary artery dissection?

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

3. How would you rate your knowledge of the management of stable pregnancy-associated spontaneous coronary artery dissection?

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

4. How would you rate your knowledge of the management of unstable pregnancy-associated spontaneous coronary artery dissection?

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

5. How would you rate your ability to facilitate a multi-disciplinary discussion regarding management of pregnancy-associated spontaneous coronary artery dissection?

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

Appendix 2

SIMULATION ACTIVITY EVALUATION FORM

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

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