

The Unexpected in the Expecting: Anesthesia for Penetrating Trauma on a COVID-19 Suspect Parturient: A Case Report

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ABSTRACT

Physical trauma significantly influences pregnancy outcomes leading to fetomaternal morbidity or mortality. A 20-year-old G₁P₀ (33 weeks 4/7 days AOG) COVID-19 suspect was accidentally impaled by a falling metal rod while aboard her electric scooter. This paper highlights the peculiarities of anesthetizing a parturient with an impaled foreign body in the abdominal cavity while ensuring the well-being of the fetus amidst the challenges of the COVID-19 pandemic.

Keywords: penetrating wounds, pregnancy, fetal monitoring, COVID-19

INTRODUCTION

Trauma in obstetrics affect 1 in 12 pregnancies.¹ It has significant impact on maternal outcomes and is the leading cause of non-obstetric maternal deaths.^{1,2} It increases the incidence of spontaneous abortion, preterm premature rupture of membranes, preterm birth, uterine rupture, cesarean delivery, placental abruption and stillbirths.³

Injuries from trauma can be classified as minor or major. Minor trauma refers to those that does not involve the abdomen, rapid compression, deceleration or shearing forces or one wherein there is absence of reported pain, vaginal bleeding, loss of fluid or decreased fetal movements. Despite its minor nature, 60 – 70% of trauma-related fetal losses are due to minor trauma.¹ Major trauma is associated with the risk of death or impairment of either mother and fetus, need for hospital or complex resources for treatment, negative effect on quality of life and prolonged recovery.

In terms of mechanism of injury, the most common pregnancy-related trauma is motor vehicular crash with an incidence of 207/100,000 live births. In contrast, penetrating trauma is quite rare with an incidence of 3.27/100,000 live births.³

Based on the only available 2 retrospective studies regarding penetrating trauma in pregnant patients, 73% were handgun-related, 23% were knife-related and 4% were shotgun-related.^{3,4} Fetal mortality can be as high as 73% while reported maternal mortality was 14.3%. It is also associated with increased hospital stay and complications like ileus compared to blunt abdominal trauma.³

Issues arising when managing obstetric trauma patients include knowledge of the anatomic and physiologic changes in a pregnant woman, assessment of the fetus, exposure to

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possible radiation and/or potential teratogens.⁴ Evaluation and management of the pregnant patient with major trauma is a challenge since two patients are simultaneously potentially at risk and the appropriate course of action has to be conducted promptly to achieve a favorable outcome.

CASE PRESENTATION

A 20-year-old otherwise healthy G₁P₀ (33 weeks 4/7 AOG) was a passenger in an electric scooter when a meter-long inch-thick metal rod fell from the 4th floor of a construction site. The metal rod impaled her by entering through her right supraclavicular area and exiting at the hypogastric area, above the symphysis pubis. The patient experienced severe generalized pain and noted decreased fetal movement. However, there was no associated loss of consciousness, dyspnea, vaginal bleeding and watery vaginal discharge.

First aid measures done at a nearby hospital included intravenous fluid resuscitation, oxygen supplementation and administration of a dose of dexamethasone for fetal lung maturity. She was then transferred to this tertiary hospital for further management and possible isolation in a COVID-19 facility.

Upon arrival at the ER, the patient was noted to be awake, spoke in complete sentences and oriented to 3 spheres. Vital signs were BP 130/100 mmHg, HR 120 bpm, RR 22 cpm, SpO₂ 99% on room air. Pertinent PE findings were pink conjunctiva, 2–3 mm pupils that were equally reactive to light, rapid shallow chest expansion, clear and

equal breath sounds, and good peripheral pulses. A metal rod was seen going through and through with 42 cm extending out from the right midclavicular line anterior to the clavicle and exiting the mid-hypogastric area with 5 cm protruding from the exit point (Figures 1A and 1B). She had a fundic height of 27 cm, cephalic in presentation with good fetal heart tones. Pelvic examination revealed closed cervix with no active bleeding.

Complete blood count (CBC) and bleeding parameters were within normal limits. Focused Assessment Sonography for Trauma (FAST) done revealed minimal subdiaphragmatic fluid, no pleural effusion, and no pericardial effusion. Chest X-ray showed no hemothorax, no pneumothorax and a metallic structure entering the superior aspect of the right hemithorax, continuing inferomedially in the anterior portion of the thoracic cavity and traversing the dome of the right hemidiaphragm into the right hemiabdomen (Figures 2A and 2B). Abdominal x-ray revealed no pneumoperitoneum and a metallic structure coursing from the right hemithorax in a diagonal manner anterior to the visualized fetal osseous structures in the right hemiabdomen and exiting anterior to the symphysis pubis through the midline of the inferior abdominal wall (Figures 3A and 3B). Abdominal ultrasound showed the rod penetrating through the uterus with possible involvement of the fetal face (Figure 4).

On baseline intrapartum monitoring, category II trace of fetal tachycardia (160–165 bpm) of moderate variability with accelerations and no decelerations were seen. The patient was given oxygen supplementation and additional crystalloid fluids which improved the intrapartum tracing.

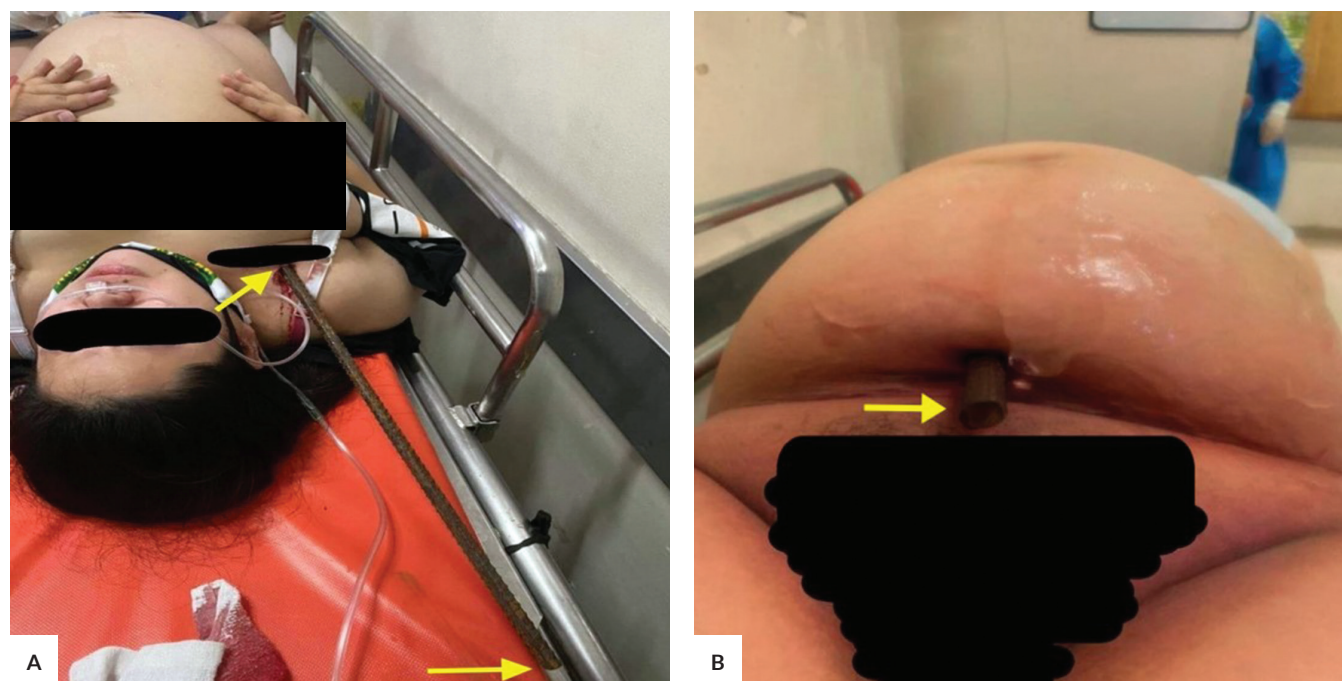


Figure 1. (A) The rod is seen entering the right supraclavicular area (yellow arrows). (B) The rod is seen exiting in the midline supra-pubic area (yellow arrow).

A quick multidisciplinary meeting was conducted to map out the management of the mother and fetus. Provisions for massive blood transfusion protocol activation and preparations for a possible ex utero intrapartum treatment (EXIT) procedure were done. Due to the pending SARS-

CoV-2 RT-PCR result, she was brought to the COVID-19 operating room.

Standard ASA monitors, additional large-bore peripheral IV line and arterial line were placed on the patient. Baseline vital signs were BP 140/90 mmHg, HR

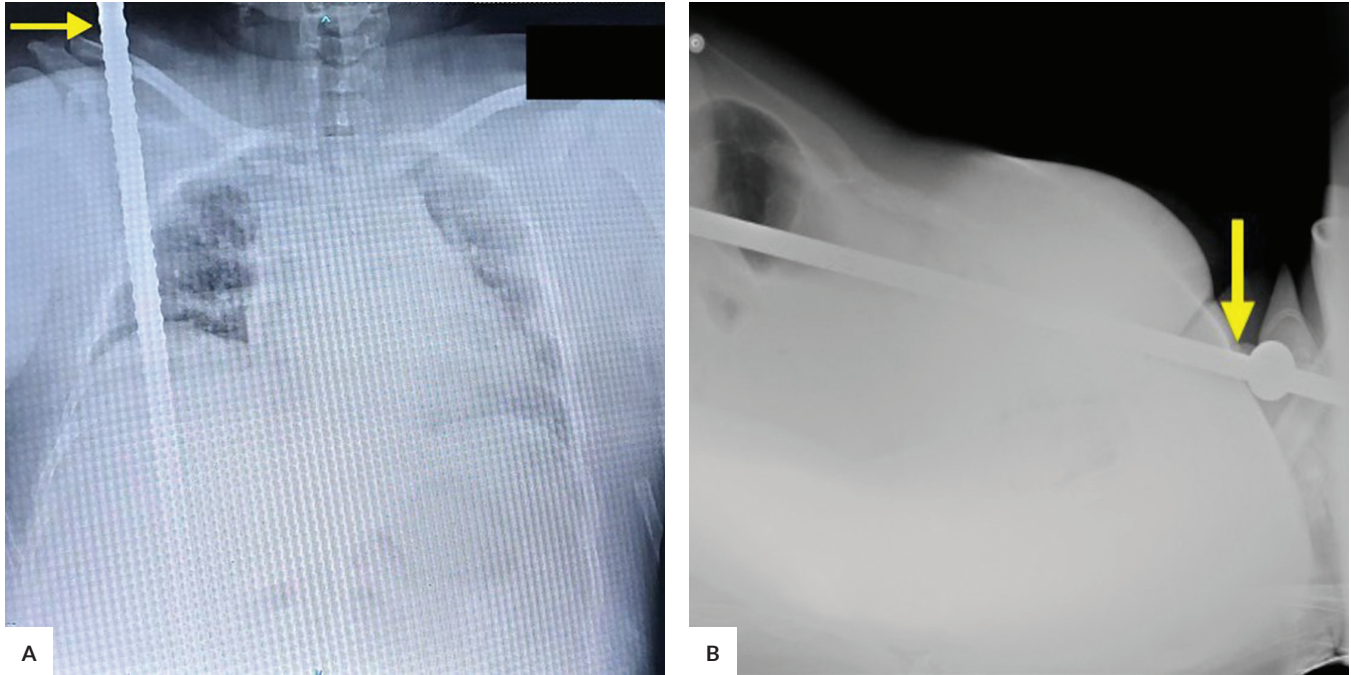


Figure 2. (A) Supine chest x-ray PA view showing course of the rod (yellow arrow). (B) Supine chest x-ray lateral view showing the course of the rod (yellow arrow).

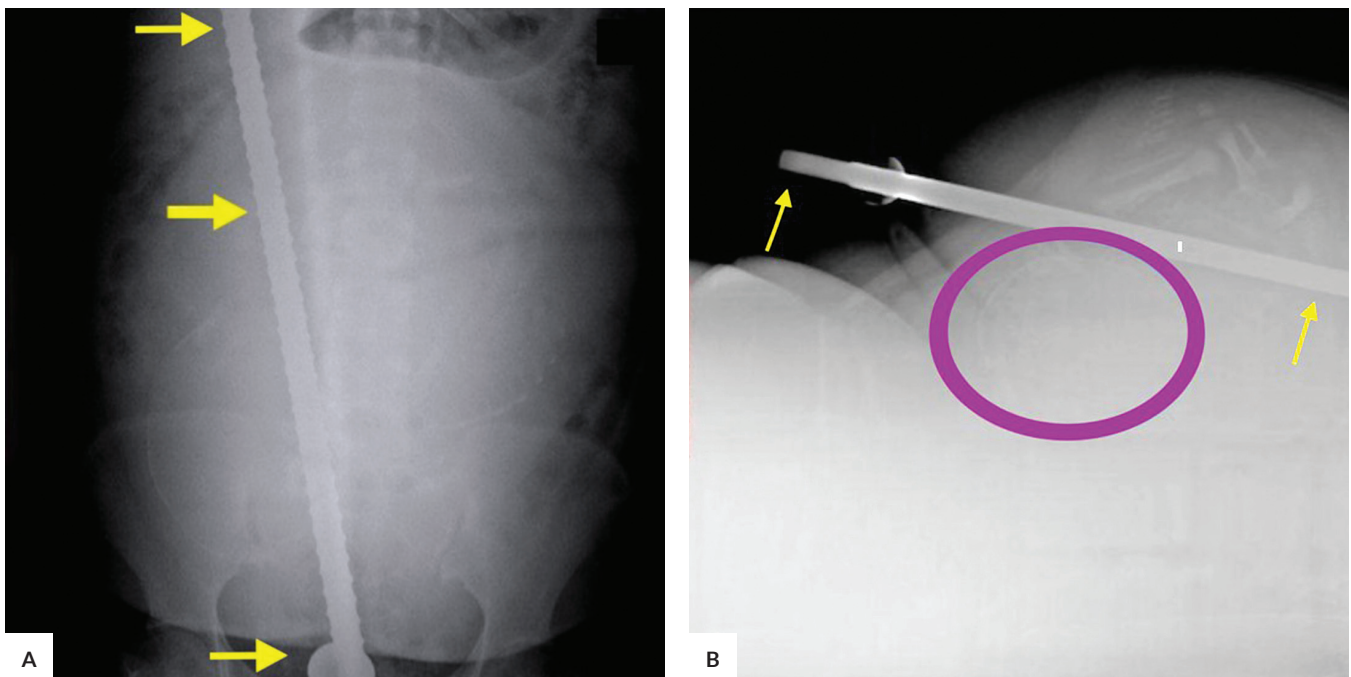


Figure 3. (A) Abdominal x-ray PA view showing the course of the rod (yellow arrows). (B) Abdominal x-ray lateral view showing the course of the rod (yellow arrows) and fetal osseous structures (encircled).

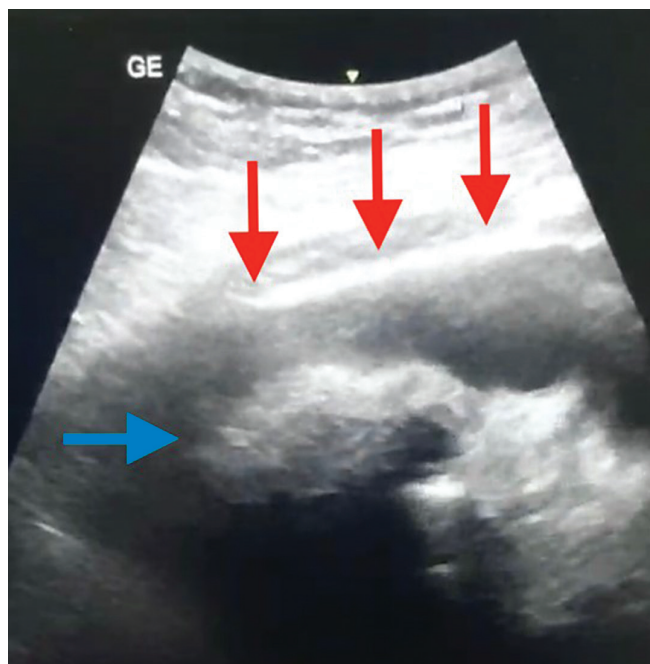


Figure 4. Abdominal ultrasound showing the relationship of the metal rod (red arrows) and the fetus (blue arrow).

120 bpm, RR 25 cpm, SpO₂ 99% on O₂ supplementation. She received dexamethasone 5 mg and metoclopramide 10 mg intravenously. Sterofundin and Gelofusine were co-loaded while blood products were brought up from the blood bank. Preoxygenation started simultaneously with prepping of the surgical site. Rapid sequence induction commenced using propofol 100 mg and rocuronium 100 mg intravenously. Cricoid pressure was applied and she was successfully intubated with cuffed ETT 7.0 using blade 3 Storz C-MAC Videolaryngoscope (Karl Storz, Tuttlingen, Germany).

Incision was done immediately after securing the airway. IV fentanyl 100 mcg and IV tranexamic acid 1 gram were given. The patient was maintained on sevoflurane at 2.5 vol% and remifentanyl TCI at 2.0 ng/ml. MV settings were volume control (6 mL/kg), RR 12 and PEEP of 5 cm H₂O. Vital signs ranged from BP 90-110/60-70 mmHg (MAP 65), HR 90-120 bpm, SpO₂ >95%, ET CO₂ 30-35 mmHg. Phenylephrine boluses and norepinephrine infusion were used sparingly to maintain a MAP of 65 mmHg.

Upon incision for the exploratory laparotomy, no active bleeding sites and minimal hemoperitoneum were noted. The obstetrician proceeded with performing a classical Cesarean section. Seventeen minutes later, a live 2200 g baby boy was delivered. He was limp, cyanotic and apneic with no gross external injuries. Immediate chest compression was performed. Initial intubation attempts failed due to presence of blood-tinged secretions in the oral cavity. On the 3rd attempt, the baby was successfully intubated. The APGAR scores were 1, 3, 6, 7. He was transferred to Neonatal ICU (NICU) for management.

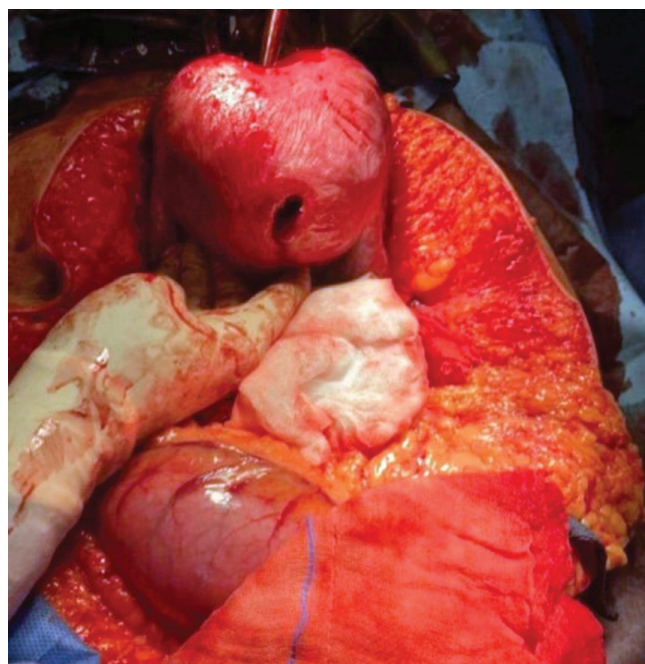


Figure 5. Uterus with impaled rod removed.

After delivery, the metal rod was withdrawn from the uterus (Figure 5) but was still within the abdominal cavity. Uterine incision and perforation were repaired. IV carbetocin 150 mg, IV carboprost 250 mcg and IM Methergine 100 mcg were given. Sevoflurane concentration was decreased to 1 vol%. The general surgeon continued the surgery and noted that although the metal rod did not injure the stomach, small intestines and colon, it penetrated the mesentery of the transverse colon. Further cephalad, the metal rod perforated the diaphragm and liver segment IV (Figures 6A and 6B). Hepatotomy on liver segment IV was done to facilitate atraumatic removal of the rod. The metal rod was then withdrawn further up to the level of the liver.

At this point, the thoracocardiovascular surgeons proceeded with anterolateral thoracotomy. It was noted that the metal rod entered through the subcutaneous layer of the chest coursing through the right 5th intercostal space injuring the anterior lip of the diaphragm. The lungs, heart and major blood vessels were not injured. After phrenicorrhaphy, the 105 cm metal rod was withdrawn from the entry point and right chest tube thoracostomy (CTT) was done.

A total of 2 liters of blood loss were incurred which were replaced with 1500 ml crystalloids, 500 ml Gelofusine and 2 units each of packed RBC, FFP and platelet concentrate. Transfusion and resuscitation efforts were guided by i-STAT point-of-care (Abbott Point of Care, East Windsor, NJ) and ASA monitors.

At the end of the surgery, the patient received IV ketorolac 30 mg and IV paracetamol 1000 mg. The patient was placed on a left lateral decubitus position while still

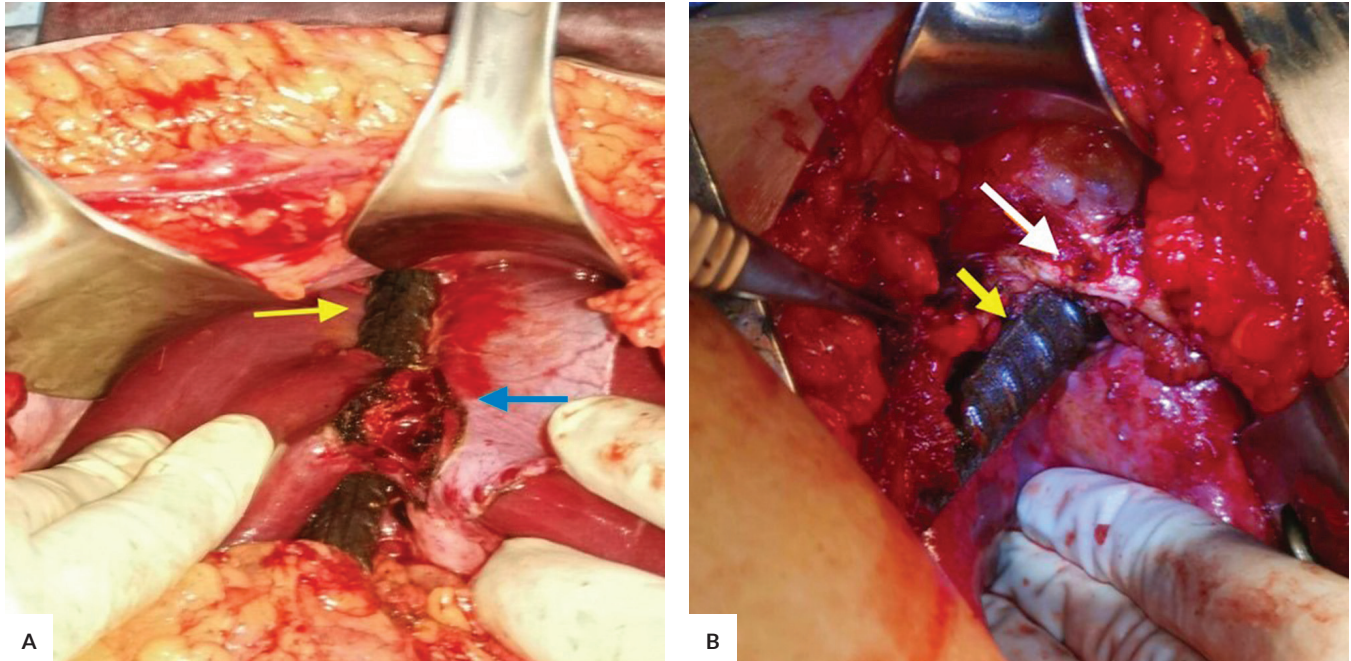


Figure 6. (A) Metal rod (yellow arrow) perforating the diaphragm (blue arrow). **(B)** Metal rod (yellow arrow) perforating segment IV of the liver (white arrow).

intubated. An epidural catheter was inserted aseptically at T12-L1 using Tuohy needle gauge 18. Ten ml of 0.125% bupivacaine plus 0.02% morphine was given via the epidural catheter. Neuromuscular blockade was reversed with IV Sugammadex 2 mg/kg. She was then extubated after fulfilling the extubation criteria.

Total operative time was 5 hrs and 18 minutes. The patient tolerated the procedure well. Post-operative vital signs were BP 100/70 mmHg, HR 88 bpm, RR 20 cpm, SpO₂ 100%. Her RT-PCR result turned out to be negative and she was transferred to the regular ward for closer monitoring. The CTT was removed on the 4th post-operative day. She was co-managed with Psychiatry for mental wellness assessment and counselling. Her baby received surfactant, antibiotic and inotropes while in the NICU and was extubated on the 5th day of life. Mother and baby were discharged well eight and eleven days, respectively.

DISCUSSION

Twenty percent of maternal demise can be attributed to trauma-related injuries during pregnancy.⁴ In terms of anatomical region of involvement, the abdomen ranks third with a frequency of 13% following extremities (1st, 34%) and head (2nd, 20%).⁵ Anatomic and physiologic changes accompanying pregnancy alters the pattern of injury which has an implication in the assessment, interpretation of results, and management of a pregnant trauma patient.

Similar to a non-pregnant patient, primary assessment of an acutely injured pregnant patient should immediately

identify life-threatening injuries and institute patient stabilization measures focusing on ABCDE – airway, breathing, circulation, disability and exposure.⁴ After stabilization, secondary assessment is directed in identifying significant injuries, assessing fetal age and viability (≥23 weeks AOG) which should prompt immediate fetal heart rate monitoring and obstetrical consult.⁴

The patient was conversant and had a patent airway. Pain-induced tachypnea on top of pregnancy-induced respiratory alkalosis shifts the maternal oxygen dissociation curve to the left. In addition, the fetus has increased basal oxygen consumption and marked sensitivity to maternal hypoxia, hence, the need for early oxygen supplementation to maintain maternal SpO₂ above 95%.⁴

Pregnant patients have a 30-50% increase in blood volume by the third trimester.^{1,2} This hypervolemic state is an adaptation to protect the mother from the adverse effects of delivery-induced blood loss. However, it also means that a parturient may lose as much as 1.5 to 2 L of blood before showing signs of hypovolemic shock.²

Adequate maternal perfusion of vital organs is maintained at the expense of uteroplacental and splanchnic perfusion.² Uterine blood flow may decrease by as much as 20% before the mother shows signs of hypovolemia.⁶ Thus, simultaneous fetal monitoring should be done to ensure that ongoing maternal resuscitation is adequate. In fact, a nonreassuring fetal heart rate (FHR) pattern may be the first sign of significant maternal intravascular volume loss.⁴ The fetal tachycardia pattern observed in this patient improved after administration of additional fluids and oxygen supplementation.

Traditionally, trauma victims were resuscitated with large volumes of crystalloids prior to corrective surgery in an effort to replenish lost volume and maintain normal perfusion. Recognizing that overinfusion of crystalloids can cause further bleeding by increasing the arterial and venous pressure, dislodging formed clots and promoting dilutional coagulopathy gave birth to damage control resuscitation (DCR).^{7,8}

One of the elements of DCR is brief permissive hypotension with the aim of keeping the blood pressure low enough to avoid clot dislodgment while maintaining an adequate perfusing pressure.⁹ The uteroplacental circulation does not possess autoregulation with flow being directly proportional to uterine perfusion pressure and inversely proportional to uterine vascular resistance.¹⁰ There are currently no evidences supporting permissive hypotension use for pregnant trauma patients. These were the reasons why permissive hypotension was not used in this patient. However, the other components of DCR such as early use of blood products and tranexamic acid administration were performed.

As the uterus enlarges, the adjacent abdominal visceral organs are displaced to accommodate it. The classic peritonitis and abdominal guarding that accompanies hemoperitoneum is less likely to be appreciated due to the displaced omentum and relaxed, stretched abdominal wall.^{4,11} Ultrasound is a rapid, non-invasive tool that has largely replaced direct peritoneal lavage in detecting traumatic intra-abdominal injury. It has been shown to have a sensitivity of 85.7% and specificity of 99.7% among pregnant patients who sustained abdominal trauma.¹² It is worth mentioning that since the gravid uterus may distort the usual landmarks in the pelvic view of FAST, assessment of the pouch of Douglas for presence of hemoperitoneum entails a meticulous approach and an experienced operator.¹³

Determination of the entrance and exit point of penetrating trauma is important to ascertain possible organ injury of both the mother and the fetus. In contrast to a stab or gunshot wound wherein the offending agent initially enters thru the anterior abdominal wall with an anteroposterior trajectory or the back with a posteroanterior trajectory, the impalement injury in this patient had a craniocaudal trajectory encompassing the thoracic and abdominal regions.

Beyond 12 weeks AOG, the uterus becomes an abdominal organ rendering it vulnerable to injuries.^{1,6,11} Uterine displacement of abdominal organs upward, laterally and posteriorly makes abdominal injuries less likely to occur.¹¹ However, since the trajectory of the rod in this case did not follow the anteroposterior fashion, this protective effect of the uterus did not hold true as evidenced by the penetration of liver segment IV and mesentery of the transverse colon. The impalement did not involve an acceleration deceleration mechanism, hence, placental abruption is less likely and did not occur in this patient.¹

The patient was hemodynamically stable allowing for sufficient time to mobilize the different services to create a

tailored multidisciplinary approach. Despite the prematurity of the fetus, the impaled rod in the uterus posed risks to the mother and fetus. It required direct visualized surgical removal making EL and cesarean section the only viable option to remove the foreign body and save both the mother and the baby. A high index of suspicion for fetal facial injury brought upon by the through and through uterine penetration seen in the UTZ mandated provisions for EXIT procedure.

Due to the complex nature of the contemplated surgical procedures, general anesthesia was favored over neuraxial anesthesia. Parturients are considered at risk for aspiration due to decreased lower esophageal sphincter tone, upward displacement of stomach and increased gastric emptying time requiring rapid sequence induction regardless of the fasting status.^{2,6} Metoclopramide use may be considered for aspiration prophylaxis among parturients prior to surgery.¹⁴ The uncertainty regarding the COVID-19 status of the patient prompted the use of a videolaryngoscope to create a greater distance between the patient's airway and the anesthesiologist compared to direct laryngoscopy. There were no plans for a video-assisted thoracoscopic approach for the thoracic injury component, hence, there was no need to use a double-lumen ETT.

The conduct of the general anesthesia prior to the delivery of the baby in this patient was different from the traditional general anesthesia for emergency Cesarean section in that it incorporated elements suitable for EXIT procedure, i.e., profound uterine relaxation and adequate uteroplacental blood flow with the use of relatively high dose of sevoflurane and measures to keep the MAP at 65 mmHg.¹⁵ However, this may render the patient susceptible to uterine atony, thus, three types of uterotonics were given sequentially to this patient.

The neonate initially presented with poor APGAR scores which could be due to his prematurity, possible compromised uteroplacental blood flow secondary to pain-induced release of catecholamine which was not addressed preoperatively, fetal exposure to sevoflurane and remifentanyl and >3 minutes interval from incision to delivery of the baby. However, it is not due to neuromuscular blocking agent as this class of drug that does not cross the placenta.¹⁰

Remifentanyl is an ultra-short-acting opioid that is metabolized by plasma and tissue esterases and has a context-sensitive half-life of 3-4 minutes independent of the duration of infusion.¹⁶ Use of this opioid would allow the anesthesiologist early assessment of the patient's respiratory effort after the surgery.

Thoracic epidural anesthesia was incorporated in the post-operative care of the patient as it has been proven to improve pain control, reduce pulmonary complication and decrease duration of postoperative ileus.¹⁷ Together with parenteral analgesics, it provided an uneventful recovery for the patient.

Independent risk factors predictive of fetal demise on a parturient involved in trauma includes penetrating injury

mechanism, severe abdominal injury and maternal hypotension upon admission.⁵ On the other hand, head injuries, need for blood transfusion and presence of co-morbidities are factors that increase the risks of maternal mortality.¹⁸ Despite the penetrating injury mechanism, there was no direct injury to the fetus. Early resuscitation and timely definitive multidisciplinary management of the parturient contributed to the favorable maternal and fetal outcome.

CONCLUSION

Successful anesthetic management of a parturient with an impaled metal rod on the abdominal cavity on the 3rd trimester of pregnancy involves thorough preoperative assessment including FAST, tailored multidisciplinary approach, adequate maintenance of uteroplacental perfusion via judicious use of fluids and blood products, and early oxygen supplementation, appropriate monitoring incorporating use of arterial line and point of care testing, and timely administration of balanced anesthesia and multimodal analgesia to promote early maternal recovery.

Declaration of Patient Consent

The authors certify that they have obtained appropriate patient consent forms granting use of the patient's images and clinical information for publication. The patient understands that her name and initials will not be published and due efforts will be made to conceal her identity but anonymity cannot be guaranteed.

Statement of Authorship

ANCO participated in writing both the revised and final manuscript while JAT collected the data and created the draft manuscript. Both authors approved the final version of the manuscript.

Author Disclosure

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