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The Challenge of Cesarean Section at the Time of Aortic Dissection Surgery

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Background	Cardiac surgery during pregnancy, particularly when requiring hypothermic circulatory arrest (HCA), presents a complex clinical challenge. This report describes the management of a 34-week pregnant patient presenting with acute Stanford Type A aortic dissection necessitating both cesarean section (CS) and aortic arch replacement.
Summary	A 42-year-old woman at 34 weeks gestation presented with chest pain and was diagnosed with an aortic dissection extending from the aortic root distally into the descending aorta. Given fetal viability and the high risk associated with HCA, the obstetrics team proceeded with CS in the cardiac operating room under controlled hemodynamic conditions. Post-delivery, with concern for uterine hemorrhage due to the large raw surface area after placental removal in the setting of anticipated full heparinization for HCA, 30 units of oxytocin were administered, a Bakri balloon was inserted, and a two-hour delay was implemented between hysterotomy closure and systemic heparinization. The cardiac surgical strategy focused on minimizing coagulopathy and postpartum hemorrhage. Right axillary artery cannulation with antegrade cerebral perfusion limited the nadir of hypothermia to 26°C. A multi-branched arch graft facilitated Zone 2 arch replacement, enabling rapid lower body reperfusion via a second arterial cannula through a graft sidearm. The patient's bovine arch anatomy dictated anastomosis of a single graft limb to the combined innominate-left carotid artery. These measures resulted in an efficient cardiac procedure without blood product transfusion and minimal intrauterine drainage. The patient recovered to baseline neurological status, had an uncomplicated postoperative course, and was discharged home with a healthy baby.
Conclusion	A multidisciplinary approach is essential for managing pregnant patients requiring cardiac surgery. Concurrent CS and HCA pose significant challenges related to coagulopathy and hemorrhage. Collaborative strategies are crucial to mitigate uterine bleeding and minimize the risk of a hypocoagulable state.
Key Words	aortic dissection; hypothermic circulatory arrest; pregnancy; postpartum hemorrhage; periviable birth

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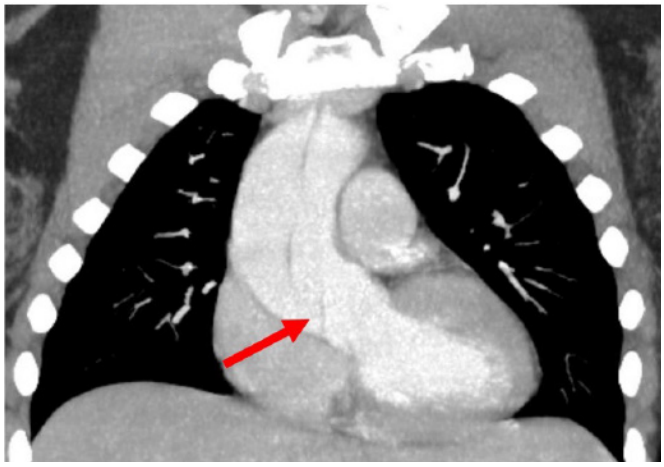
Case Description

Hormonal changes during pregnancy, including decreased aortic media integrity and increased circulatory volume and cardiac output, elevate hemodynamic stress on the aortic wall, increasing the risk of dissection.[1,2] While pregnancy-associated aortic dissection is rare (0.0004% of pregnancies), it accounts for 0.1% of all aortic dissections and approximately half of those in women of childbearing age.[1]

Our patient is a 42-year-old female at 34 weeks gestation with a history of hypertension presented with chest pain radiating to her back. Computed tomographic angiography revealed a Stanford Type A aortic dissection originating near the sinotubular junction and extending distally into the aortic arch and descending aorta (Figure 1).

Figure 1. CT Angiogram. Published with Permission

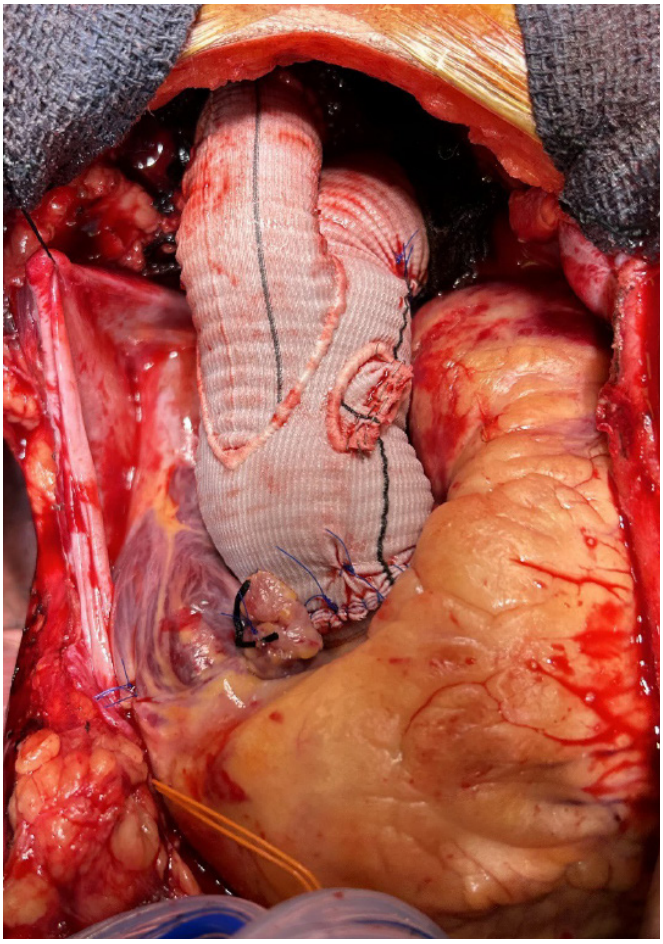


Stanford Type A aortic dissection originating at the sinotubular junction and extending distally through the aortic arch and into the descending aorta.

Given fetal viability and the high risk of fetal mortality with hypothermic circulatory arrest (HCA), cesarean section (CS) proceeded effortlessly in the cardiac operating room under controlled maternal hemodynamics. Concerns for uterine hemorrhage were high due to full heparinization, HCA with resulting hypocoagulable state, and a large raw uterine surface area after placental removal. In response, an intra-uterine Bakri balloon was placed, 30 units of oxytocin administered, and a two-hour delay implemented between hysterotomy closure and full heparinization.

The cardiac surgical strategy prioritized minimizing coagulopathy. Preoperative transesophageal echocardiography demonstrated normal biventricular function, trace aortic regurgitation, and no pericardial effusion. Right axillary cannulation with antegrade cerebral perfusion limited hypothermia to 26°C. A multi-limbed woven polyester aortic arch graft facilitated Zone 2 arch replacement with rapid lower body reperfusion via a second arterial cannula through a graft sidearm. The patient's bovine arch anatomy allowed for antegrade cerebral perfusion through both carotid arteries and a single anastomosis to one graft limb (Figure 2). The aortic valve appeared intact, and the aorta was replaced from the sinotubular junction to Zone 2 of the aortic arch. Total cardiopulmonary bypass time was 154 minutes, with 74 minutes of aortic cross-clamp time and 16 minutes of HCA.

Figure 2. Intraoperative Photo. Published with Permission



Completed repair with replacement of the ascending aorta and Zone 2 aortic arch using a single-limb graft anastomosed to the patient's bovine arch configuration.

The patient required no blood products intraoperatively. Post-cardiopulmonary bypass echocardiography confirmed competent aortic valve coaptation. Her postoperative recovery was uneventful, and she was discharged home with her healthy baby.

Discussion

For the mother, combined aortic dissection surgery and CS carry significant risks, including postpartum hemorrhage due to the combined abdominal incision and hysterotomy, exacerbated by intraoperative heparinization and potential hypocoagulability following HCA. For the fetus, the risk of mortality from HCA must be weighed against the risks of premature delivery via CS. These complex decisions necessitate a multidisciplinary approach involving obstetrics, neonatology, and cardiothoracic surgery.

Fetal morbidity and mortality are major concerns whenever cardiac surgery with cardiopulmonary bypass is required. An inverse correlation exists between mortality rates and gestational age (GA), with reported mortality as high as 95% before 23 weeks GA, improving to approximately 2% by 28 weeks GA.[3] Consequently, delivery prior to cardiac surgery is generally recommended for fetuses with GA greater than 28 weeks.[4]

The alternative—cardiac surgery during pregnancy—carries a maternal mortality rate of approximately 1.5%, comparable to that in non-pregnant women undergoing similar procedures.[4] However, fetal mortality during cardiac surgery is reported between 20-30%,[4–7] varying by trimester: 30% in the first, 24% in the second, and 6% in the third.[6]

Fetal mortality during CPB is thought to be due to uteroplacental hypoperfusion leading to fetal hypoxia.[5] Oxygen delivery is affected by both non-modifiable factors (intrinsic arteriovenous mixing and fetal hemoglobin oxygen dissociation characteristics) and modifiable factors (maternal pH and hematocrit).[8]

Uterine relaxation is crucial for maintaining placental perfusion and fetal oxygenation. Persistent uterine contractions can induce fetal hypoxia, a key factor in fetal demise.[5,8] Tocolytics assist in maximizing blood flow in these situations.[8]

Placental perfusion also depends on adequate maternal blood pressure. Maternal hypotension reduces placental perfusion, precipitating uterine contractions.[5] Similarly, vasopressors that cause splanchnic vasoconstriction can compromise placental perfusion. Pulsatile flow is essential for maintaining low placental vascular resistance; the non-pulsatile flow of CPB increases resistance, reducing placental perfusion.[9]

Goals to optimize placental perfusion during CPB include maintaining a mean arterial pressure above 70 mmHg, minimizing vasopressor use, maintaining a hematocrit above 28%, and maintaining normothermia. Pulsatile flow is ideal but often not achievable during CPB.[5,9] Lastly, intraoperative fetal monitoring can assist in detecting fetal distress through the assessment of bradycardic events.[5]

The detrimental effects of CPB are amplified in the context of HCA. HCA imposes greater metabolic stress, complete cessation of uterine blood flow, and profound hypothermia compared to CPB without HCA. Reported fetal mortality rates are extremely high in these cases, with only isolated reports of neonatal survival, with one describing significant neurological sequelae.[10–12]

Postpartum hemorrhage after combined CS and cardiac surgery remains a significant concern due to coagulopathy combined with the large uterine surface area. Hysterotomy closure techniques, intrauterine Bakri balloon placement, and delaying full heparinization after CS can mitigate bleeding complications. Leaving the abdomen open during the cardiac procedure with delayed closure after heparin reversal is another option.[6] Intrauterine pressure and uterotonics improve hemostasis from uterine perforator arteries.[13] In refractory bleeding cases, when these measures and correction of coagulopathy fail, hysterectomy may be necessary.[13]

Conclusion

Optimal fetal outcomes in pregnant patients requiring cardiac surgery are achieved when delivery precedes cardiopulmonary bypass. When pre-cardiac surgery delivery is not feasible, prioritizing cardiopulmonary bypass flow parameters that maximize placental perfusion offers the best opportunity for fetal survival. HCA introduces another layer of fetal metabolic demand, resulting in poor fetal outcomes. Lastly, when undertaking any cardiac surgery, special attention must be given to minimizing the elevated risk of postpartum hemorrhage.

Lessons Learned

A multidisciplinary approach is paramount for managing pregnant patients requiring cardiac surgery due to the complex interplay of coagulopathy and hemorrhage following cesarean section, cardiopulmonary bypass management, and potential HCA. While pregnancy-associated aortic dissection is rare, familiarity with management strategies regarding delivery timing, cardiopulmonary bypass protocols, and heparinization is crucial to minimize maternal and fetal mortality.

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