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Anesthetic management of bed-to-bed surgery for epicardial pacemaker implantation in neonates with congenital complete heart block: Case report

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Abstract

Congenital complete heart block is a rare disease. Pacemaker implantation is indicated in neonates with a heart rate of less than 50 beats per minute. This case report aims to emphasize perioperative management of two cases of congenital complete heart block that underwent pacemaker implantation bed to bed after being delivered by cesarean section. Since these patients are prone to fatal cardiac decompensation and unresponsive to pharmacological therapies, it requires some measures in anesthetic management and good teamwork with other specialties.

Keywords

Congenital complete heart block, anesthesia management, pacemaker implantation

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Introduction

Congenital complete heart block (CCHB) is a rare disease; by increasing the usage of prenatal ultrasound and the development of fetal echocardiography, it can be diagnosed as early as 18 weeks intra-uterine. Thus, early management and therapy can be instituted.[1]

In isolated CCHB, 60%–90% of the cases are caused by lupus erythematosus in which the maternal antibody is believed to cross the placenta and cause heart block in the fetus. Corticosteroids can be used as a therapy to prevent heart tissue injury.[1] Pacemaker implantation is indicated in newborns with a heart rate (HR) <50 bpm because the cardiac output of neonates highly depends on HR. Therefore, a decrease in HR can cause heart failure in neonates.[2] Pacemaker implantation in children, especially in neonates, needs anesthetic management that requires special measures as these children are at high risk for cardiac decompensation during the perioperative period. Good preparations, including proper monitoring tools, sympathomimetic drugs, and temporary pacing, should be available, along with good teamwork. After we have written informed consent from the parents of both babies, we report two cases of perioperative management in an elective bed-to-bed epicardial pacemaker implantation in neonates with CCHB at our hospital.

Cases

Case 1

A male neonate was delivered with an elective cesarean section in week 38 of gestation due to a complete heart block. The heart condition had been diagnosed *in utero* at 28 weeks of gestation by the obstetrician and confirmed with fetal echocardiography by a pediatric cardiologist. The result showed that the baby has a normal heart structure. After delivery, neonatal resuscitation was done by the neonatologist. The Appearance Pulse Grimace Activity Respiration (APGAR) score was 7–9, with a ventricular HR of 40–60 bpm and an oxygen saturation of 95%–99% with spontaneous respiration. An umbilical venous catheter was placed for fluid and dopamine infusion up to 10 mcg/

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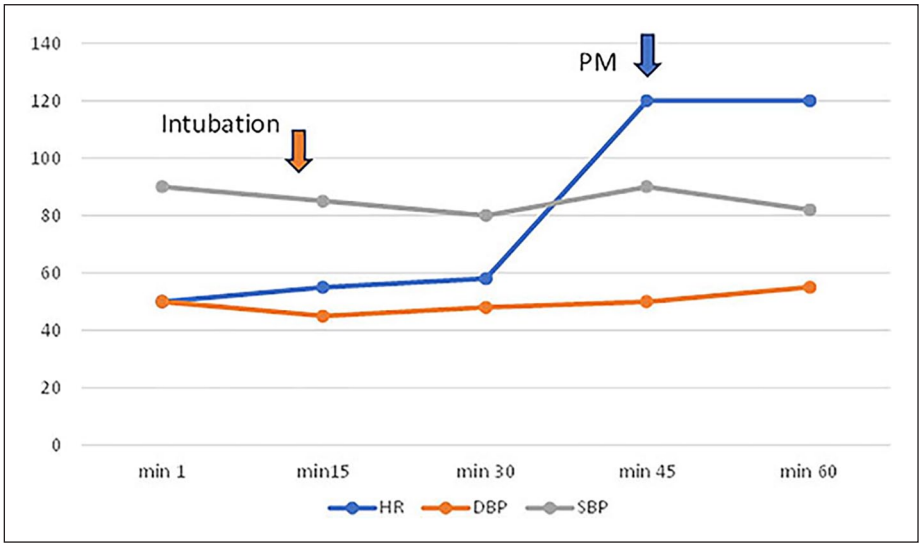

Figure 1. Hemodynamic monitoring during surgery of a 1-day-old boy.
HR: heart rate; DBP: diastolic blood pressure; SBP: systolic blood pressure; PM: pacemaker.

kg/min. After 1 h of resuscitation, the HR was still around 50–65 bpm. The team then decided to undergo pacemaker implantation and move the baby to the operating room. The transcutaneous pacing patches were placed in an anterolateral position. A peripherally inserted central catheter (PICC) was placed in the left axillary vein under local anesthesia by the pediatric surgeon. The patient was induced with 2 mg/kg ketamine and 0.1 mg/kg morphine. He was then intubated with a 3.5 ID non-cuffed endotracheal tube, facilitated with 1 mg/kg atracurium. He was mechanically ventilated with a tidal volume of 6–8 mL/kg and a respiratory rate of 40–60 breaths/min, maintaining the $ETCO_2$ at 35–45 mmHg. He received an infusion of dextrose 10% 5 mL/kg/h. To maintain normothermia, the operating room temperature was increased to 24°C and we put warm BLANKETROL^R III under the baby. During the intraoperative period, we monitored the blood pressure noninvasively and intermittently every 5 min, while the ECG, temperature, and SpO2 were monitored continuously. The hemodynamic profile during surgery is shown in Figure 1. The anesthesia was maintained with oxygen, compressed air, and sevoflurane with MAC 0.8–1.2. BP ranged between 60/40 and 80/50 mmHg, the HR was 50–60 bpm before the pacemaker. Peripheral oxygen saturation was above 95% during surgery. The epicardial pacemaker implantation was done by the cardiac surgeon via the left thoracotomy approach. The lead was placed in the lateral left ventricle and was given the Ventricle-Ventricle Inhibited (VVI) mode. The heart was paced to 120 beats/min. Following the procedure, he was transferred to the neonatal intensive care unit (NICU), extubated 2 days after, his chest X-ray results on day 1 are shown in Figure 2. He was discharged from the NICU on day 5 after surgery and discharged from the hospital on day 7 after surgery.

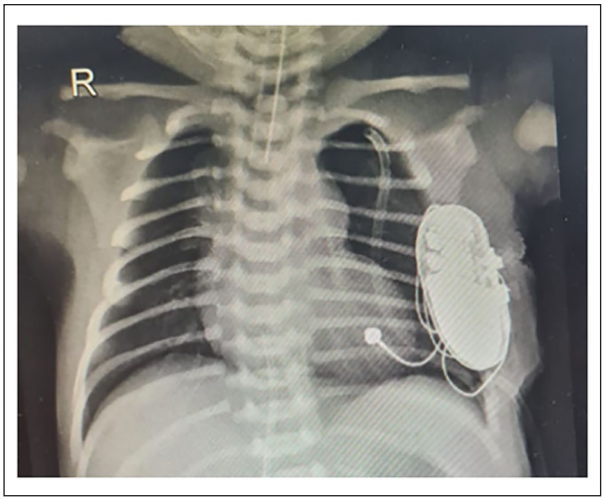

Figure 2. An anteroposterior X-ray of a 1-day-old boy after a pacemaker implantation.

Case 2

A female neonate was delivered with an elective cesarean section in week 38 of gestation due to fetal hydrops and bradycardia. She had been diagnosed with fetal hydrops and congenital heart block at 24 weeks of gestation and had been given prenatal corticosteroids since 26 weeks of gestation. From fetal echocardiography, both ventricles were dilated and there was epicardial effusion. The average fetal HR during pregnancy was 48–60 bpm. After delivery, she showed signs of respiratory distress and was intubated by a neonatologist with a 3.5 ID non-cuffed endotracheal tube. A dopamine infusion of 10 mcg/kg/min and dobutamine of 10 mcg/kg/min was started via the

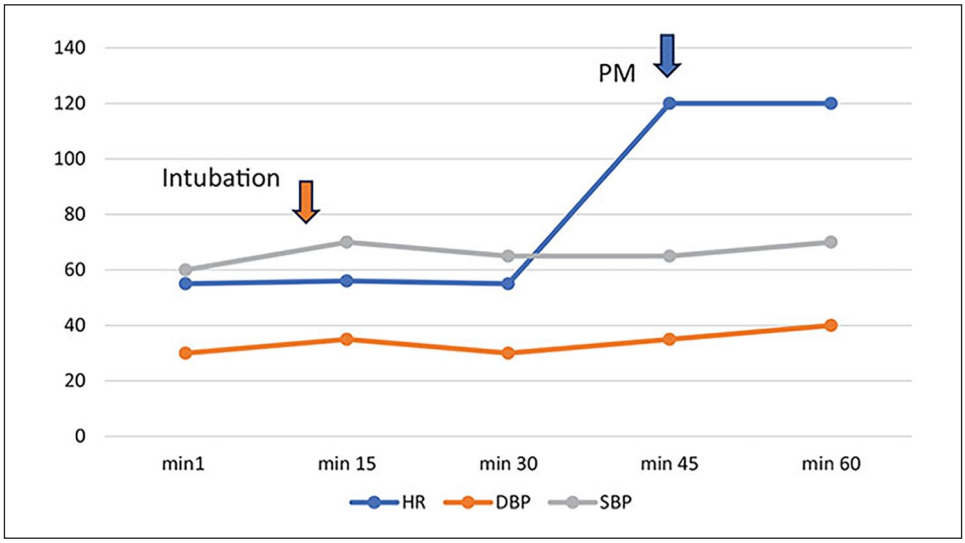

Figure 3. Hemodynamic monitoring during surgery of a baby girl.
HR: heart rate; DBP: diastolic blood pressure; SBP: systolic blood pressure; PM: pacemaker.

umbilical catheter. After 2 h of resuscitation, the HR was 40–50 bpm. The team then decided to do pacemaker implantation, and the baby was moved to the operating room. Noninvasive blood pressure (NIBP) was monitored intermittently every 5 min, while ECG, esophageal temperature, and SpO2 were monitored continuously The blood pressure was 70/40 mmHg, with an HR of 48 bpm and a SpO_2 of 99%. The transcutaneous pacing patches were placed in the anterolateral position. The PICC was inserted in the left axillary vein under local anesthesia. We started fluid, dopamine, and dobutamine infusion through the PICC line after it was placed. She received an infusion of dextrose 10% 4 mL/kg/h. Anesthesia was induced and maintained using a mixture of oxygen and air (FiO2 50%) and sevoflurane MAC 0.8–1.2. Morphine of 0.1 mg/kg was given for analgesia and 1 mg/kg atracurium was given as a muscle relaxant. Mechanical ventilation was given with a tidal volume of 6–8 mL/kg and a respiratory rate of 40–60 breaths/minute while maintaining the $ETCO_2$ at 35–45 mmHg. Normothermia was maintained by increasing the operating room temperature to 24°C and putting warm BLANKETROL^R III on the operating table. The pacemaker insertion was done via the subxiphoid approach. The lead was placed in the epicardial of the right ventricle with VVI mode and a rate of 120 bpm. The hemodynamic monitoring during surgery is shown in Figure 3. The baby was then transferred to the NICU and extubated 5 days later due to pulmonary infection. Her chest X-ray on day 1 showed infiltrate in her lungs (Figure 4) and her C-reactive protein raised to 64 mg/dL on day3. She was discharged from NICU 9 days after surgery. She was diagnosed with bacterial sepsis and responded well to antibiotics. She was discharged from the hospital on day 23 after surgery.

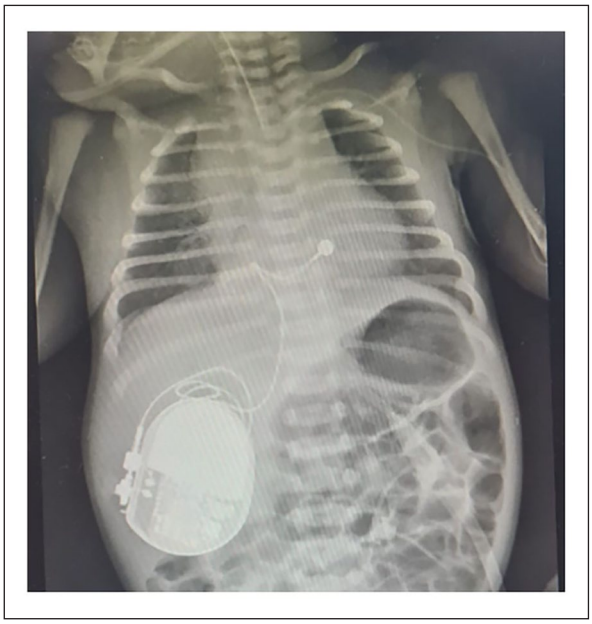

Figure 4. An anteroposterior X-ray of a 1-day-old girl after pacemaker implantation.

Discussion

CCHB is characterized by a dissociation of electrical activity between the atria and the ventricle. According to Kertesz, the survival rate of patients with Congenital Heart Block (CHB) accompanied by other heart diseases in the neonatal period is only 14%, whereas that of isolated congenital complete AV block is 85%. Both our cases were isolated CHB. In the absence of another heart disease, 60%–90% of congenital heart blocks

are caused by lupus erythematosus in which the maternal antibodies for autoimmune connective diseases cross the placenta and cause conduction abnormalities in the fetal heart tissue.[2,3]

With the increasing use of ultrasound, the diagnosis can be made as early as 18 weeks of gestation. In our cases, the babies were diagnosed at 28 weeks and 24 weeks *in utero* during fetal ultrasound by the obstetrician. Both babies were referred to a pediatric cardiologist afterward to undergo fetal echocardiography. Fetal echocardiography is the gold standard for the diagnosis of congenital heart block.[4] Steroid therapy can be used when a heart block is diagnosed intra-uterine to prevent further tissue injury of the fetal heart, although the use of steroids is still controversial due to the risk of Intra Uterine Growth Restriction (IUGR) and maternal complications. In our second case, the obstetrician gave the mother steroid during pregnancy because she had a history of fetal death in her previous pregnancy. So, the obstetrician suspected that she had an autoimmune disease. Unfortunately, they did not do further investigation. Fetuses with complete heart block may develop hydrops fetalis, myocarditis, and eventually death.[2]

Pacemaker therapy is strongly indicated in symptomatic patients or those who develop congestive heart failure, infants with a ventricular rate below 50 bpm or congenital heart disease with HR $<$70 bpm, wide QRS complex, or ventricular dysfunction.[3] In infants with severe bradycardia, pharmacologic therapy can be used as the bridging therapy while preparing for cardiac pacing. Sympathomimetic drugs such as isoproterenol, atropine, epinephrine, and dopamine are all recommended.[5] In both patients, dopamine of 5–10 mcg/kg/min was given, even though the HR was still around 50–60 bpm. Thus, pacemaker implantation was deemed necessary. During anesthesia, dopamine infusion was maintained until the pacemaker was in place. Isoproterenol was not given because it is not available in our country.

A permanent pacemaker implantation can be performed through the transvenous or epicardial approach. The transvenous approach should be done in a cardiac catheterization laboratory. It is contraindicated in patients with right-to-left shunting, prosthetic tricuspid valve, unsuitable anatomy for transvenous access, and those with a body weight of less than 10 kg. Epicardial pacing is the first-line option in children less than 10 kg and with a structurally normal heart.[3] In the epicardial approach, the leads are attached to the epimyocardial surface of the heart. It can be done via thoracotomy, sternotomy, or subxiphoid approach. The surgical approach was based on the patient's underlying cardiac anatomy, cardiac position, prior operation(s), and concurrent operation.[6] In our cases, the first baby was done via the left thoracotomy approach while the second baby was done via the subxiphoid approach. The different approach between the two cases was based on surgeon preference and also based on the condition of the patient, the second baby showed signs of congestive heart failure so the minimally invasive subxiphoid approach was preferred.

In children, the procedures require general anesthesia. When providing anesthesia care for infants with CHB, in addition to maintenance of body temperature, normovolemia, normocapnia, and normoxia, emergency drugs such as isoproterenol, atropine, epinephrine, and dopamine should also be available. Electrical measures to increase HR, like transcutaneous pacing with appropriate patch size, should be available in case extracardiac pacing becomes necessary. In both cases, we put the transcutaneous pacing patch before the anesthesia induction. Access to temporary transvenous pacing may be considered.[3] Unfortunately, our hospital lacks a catheterization laboratory facility, and it is generally contraindicated in patients with a body weight of less than 10 kg as it carries a significant risk of venous thrombosis.

Neonates are more sensitive to volume and systemic vascular resistance changes, especially in neonates with a fixed HR like those with CHB. Anesthesia can cause problems in those infants, including bradycardia, arrhythmia, hypotension, and cardiac arrest that are unresponsive to pharmacologic therapy. Since most anesthesia agents influence myocardial contractility, HR, and systemic vascular resistance, dosing should be carefully titrated, and the hemodynamic responses should be monitored. In our setting, we use NIBP. Although arterial blood pressure is considered the gold standard, NIBP also gives reliable value and is less invasive.[7] We set a 5-min interval as a standard interval and did extra measurements when needed.

Anesthesia drugs that interfere less with heart conduction are preferable. Ketamine was chosen as an induction agent in the first case because it has a less depressant effect on blood pressure and provides good cardiac output and perfusion pressure.[8,9] For anesthesia maintenance, the authors use a mixture of sevoflurane, oxygen, and air. Inhalation agents that reduce myocardial chronotropy and inotropy, while sensitizing myocardium to catecholamines, may lead to arrhythmias and reduce cardiac output.[10,11] Sevoflurane has a myocardial depressant effect smaller than another volatile agent. It maintains cardiac output and only causes little change to HR and contractility.[12] In these two cases, we did not find significant changes in HR or blood pressure upon the institution of sevoflurane.

Conclusion

CCHB is a rare disease, but with early diagnosis and treatment, the prognosis is relatively favorable. Pacemaker implantation is strongly indicated in infants with an HR below 50 bpm. Anesthesia in infants with heart block requires special precaution and monitoring. Emergency drugs and equipment to increase HR should be available in the operating room, as well as the team from other specialties. The choice of anesthesia agents that have a less depressant effect on HR and contractility is preferable.

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Author contribution

All authors participated in the making of this manuscript and account responsible for the work.

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Ethics approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed consent

Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

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