

Case report

THE ANESTHETIC MANAGEMENT OF AN EXTREMELY LOW BIRTH WEIGHT PRETERM INFANT WEIGHING 710 GRAMS UNDERGOING LIGATION OF PATENT DUCTUS ARTERIOSUS: A CASE REPORT

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Abstract

Objective Preterm and extremely low birth weight infants require meticulous anesthetic care, especially for deteriorated hemodynamic status in emergency ligation of patent ductus arteriosus.

Clinical presentation An 820 gram female infant, born at 29 weeks of gestation by Caesarean section for premature rupture of membranes, presented with infant respiratory distress syndrome associated with renal dysfunction. After incubation and admission to the neonatal intensive care unit (NICU), a severe patent ductus arteriosus was disclosed. Medical treatment was contraindicated, so ligation procedure was performed when she was 6 days old and weighing 710 grams.

Management Temperature, ventilation, and monitoring were continuously controlled during transportation and in the main operating theatre. Cannulae were inserted bilaterally into antecubital veins and a femoral artery. Electrocardiogram (ECG), arterial pressure, pre- and post-ductal oxygen saturation, end-tidal CO₂ and temperature were monitored. After induction of anesthesia by fentanyl at 1 microgram, atropine at 0.015 mg, atracurium at 0.5 mg, and ketamine at 1.0 mg intravenously; a gastric tube, and an esophageal stethoscope were passed and urine output was monitored. Anesthesia was maintained with sevoflurane. F_IO₂ was adjusted with air and oxygen. The lungs were ventilated manually with Jackson Rees apparatus. The patient was placed in the right lateral decubitus position and an incision carried out through the left thoracotomy

Conclusion An understanding of the cardiovascular pathophysiology is essential for successful management of anesthesia in an extremely low birth weight preterm infant with deteriorated hemodynamic status. **Chiang Mai Med Bull 2005;44(4):155-160.**

Keywords: anesthesia, preterm, low birth weight, PDA ligation

Preterm infants require meticulous anesthetic care for any type of surgery, especially for cardiovascular conditions, which may pose a serious hazard to the infant's life. Although ligation of patent ductus arteriosus in preterm infants is a relatively common practice,^(1,2) various complications are still a real threat in the mind of the surgeon and anesthesiologist, particularly if the infant is not only preterm, but also of extremely low birth weight and very sick. In this report, we present anesthetic management in an extremely low birth weight preterm infant weighing 710 grams, who underwent ligation of patent ductus arteriosus.

Case report

The patient was female, born at 29 weeks of gestation, weighing 820 grams, and delivered by Caesarean section for premature rupture of membranes. Her trachea was intubated 15 minutes after birth for respiratory distress. She was noted to have infant respiratory distress syndrome associated with renal dysfunction. She was admitted to the neonatal intensive care unit (NICU) straightaway. After thorough examination, a severe patent ductus arteriosus was disclosed. The possibility of pulmonary hemorrhage and heart failure could be predicted in view of the large left to right shunt. Worst of all, her poor renal function contraindicated medical treatment. Therefore, we decided to carry out the ligation procedure at once although she was premature, only 6 days old, and of extremely low body weight.

The operation was performed in the main operating theatre. Before the operation, the patient was transported to the operating theater by a radiant warmer table with plastic covering. The operating room temperature was set at 35 degrees Celsius, and the operation was planned to take place on the radiant

warmer table. In the operating theatre, she weighed 710 grams, her trachea was intubated orally (2.5 mm I.D., Portex) and cannulae were inserted bilaterally into antecubital veins and a femoral artery. After ECG, arterial pressure, pre- and post-ductal oxygen saturation, end-tidal CO₂ and rectal temperature monitoring had been attached, anesthesia was induced by fentanyl at 1 microgram, atropine at 0.015 mg, atracurium at 0.5 mg, and ketamine at 1.0 mg intravenously. After the induction of anesthesia, a gastric tube, an esophageal temperature monitor, and an esophageal stethoscope were passed and urine output was monitored. All her extremities were wrapped in cotton wrap with a plastic covering. Anesthesia was maintained with sevoflurane. F_IO₂ was adjusted with air and oxygen to maintain SpO₂ at approximately 85-90%. The lungs were ventilated manually with Jackson Rees apparatus. The patient was placed in the right lateral decubitus position. The incision was carried out through the left thoracotomy. Exposure was achieved by retracting the inflated left upper lobe inferomedially. The PDA was ligated and murmur decreased until it disappeared. The lung was re-expanded and blood loss was minimal. The peri-operative course was uneventful. After the operation, muscle relaxant was not reversed. The patient was transferred to the NICU by the radiant warmer table with the plastic covering. The patient recovered well following surgery and anesthesia.

Discussion

Low birth weight (LBW) infants are defined as infants born with a birth weight of less than 2,500 g, very low birth weight (VLBW) infants as those with a birth weight of less than 1,500 g and extremely low birth weight (ELBW) infants as those whose birth weight

is less than 1,000 g. Preterm infants are defined as neonates with a gestational age of less than 37 weeks and extremely premature infants are those born after less than 28 weeks of gestation. Postconceptual age (PCA) is defined as the sum of the gestational and postnatal ages in weeks.⁽⁵⁻⁷⁾

The opportunities for very low (birth weight <1,500 g) and extremely low birth weight infants (birth weight <1,000 g) to undergo surgery are increasing. These infants are prone to prematurity-related morbidities including respiratory distress syndrome, intraventricular hemorrhage (IVH), periventricular leukomalacia (PVL), retinopathy of prematurity, necrotizing enterocolitis and patent ductus arteriosus (PDA). PDA is a persistent fetal communication from the main pulmonary artery (PA) to the descending aorta. The incidence of this defect is 1 in 2,500 live full-term births,⁽¹⁻⁴⁾ accounting for approximately 10% of all congenital heart defects.⁽⁵⁻⁷⁾ The incidence of patent ductus arteriosus (PDA) is estimated to be approximately 45% in infants weighing less than 1,750 g at birth, and 80% in infants weighing less than 1,200 g at birth.⁽⁸⁾ Prophylactic administration of synthetic surfactant extract to infants at risk of developing respiratory distress syndrome (RDS) may lead to an increase in the incidence of PDA and pulmonary hemorrhage, while improving the clinical outcome of RDS.⁽⁹⁾ Symptoms of PDA in ELBW infants usually manifest after RDS is controlled and pulmonary vascular resistance decreases. Indomethacin is used as a standard therapy to close a PDA. Although indomethacin is more useful in closing ductus arteriosus in preterm than full term infants, some cases are refractory to pharmacological closure with indomethacin and other drugs. When the pharmacological closure fails and the he-

modynamic status deteriorates, a surgical closure becomes necessary.

Left to right shunt through the ductus arteriosus causes excessive pulmonary blood flow and decreases systemic circulation leading to diminished coronary and intestinal perfusion and tissue acidosis. Excessive pulmonary blood flow may induce pulmonary hemorrhage and increases the risk of developing chronic lung disease. Pulmonary hemorrhage is thought to be due to hemorrhagic pulmonary edema secondary to massive ductal shunting. The risk of pulmonary hemorrhage appears to occur with both synthetic surfactant products and natural surfactant extracts.⁽⁹⁾ Diminished intestinal perfusion increases the risk of developing necrotizing enterocolitis.

Doppler ultrasonic examinations may reveal a back flow velocity in the descending aorta, often termed 'diastolic steal'. Echoencephalograms may also demonstrate diastolic reversed flow in the cerebral arteries, indicating diminished flow to the brain.⁽¹⁰⁾ Diminished cerebral blood flow may lead to cerebral ischemia associated with the possible development of periventricular (PVL).

In this case, the infant had poor renal function, which was a contraindication for medical treatment,⁽¹¹⁻¹⁴⁾ and surgery was needed. Evidence is accumulating that preterm infants are also sensitive to pain and stress,⁽¹⁵⁻¹⁷⁾ so this infant was operated on under general anesthesia. The pharmacokinetics of drugs in preterm infants is not fully understood, but smaller doses of anesthetic drugs are usually required in preterm infants compared to term infants and older children, and their effects last longer due to low clearance rates and longer elimination half-lives.^(18,19) Key anesthetic considerations are (i) inspired oxygen concentration that should be adjusted to avoid

hyperoxia, (ii) hemodynamic parameters that should be kept stable and (iii) prevention of hypothermia by using adequate measures to keep the infants warm. These precautions must be continuously taken during the operation and transportation to and from the operating theatre.

The anesthesia breathing circuits for ELBW infants should have minimal dead space and resistance. For this purpose, the T-piece (Mapleson D type) circuit is the most suitable, since it has neither unidirectional valves nor a CO₂ absorber. In this case we used Jackson Rees apparatus, which can also be used for ELBW infants. It is actually used worldwide in many institutions, but there is a difficulty in connecting the circuit with a ventilator and gas scavenger system and using with a humidifier.

A peripheral venous and arterial line are needed before induction of anesthesia. A combination of fentanyl and a non depolarizing muscle relaxant is the most popular anesthetic technique. Induction of anesthesia may cause hypotension down to 30 mmHg or less of systolic blood pressure, especially in hypovolemic patients. The F₁O₂ should be maintained as low as possible to keep the SpO₂ between 85% and 95% in order to minimize pulmonary high flow. The lungs may be ventilated using the same ventilator as that used in the ward preoperatively. The operation is usually performed in the right lateral decubitus position. Esophageal stethoscope, pulse oximetry (right hand and lower extremity) and end-tidal CO₂ are essential monitoring techniques. An increase in F₁O₂ is often necessary to maintain adequate SpO₂ during surgical maneuvers using a lung spatula in the lateral position.

Ligation of a PDA may cause an acute increase in systemic blood pressure, and an abrupt blood pressure increase in the ascend-

ing aorta may induce intraventricular hemorrhage (IVH). To avoid this, in this case, systemic blood pressure was lowered immediately before the ligation of the ductus by increasing the inspired fraction of sevoflurane. Some reports describe the safety of the PDA ligation with regard to the occurrence of perioperative intracranial hemorrhage.⁽²⁰⁾ A pulse oximeter applied to a foot is useful for detecting a disastrous clipping erroneously applied to the descending aorta. Urine output has to be controlled postoperatively in the ward.

Iatrogenic events of PDA ligation or clipping include vocal cord paralysis. The prevalence of vocal cord paralysis caused by PDA ligation in preterm infants is reported to be as high as 10%, which is higher in preterm than full term infants.^(21,22) The use of a metal clip may predispose to the iatrogenic vocal cord paralysis more than a silk ligature.^(21,22) Vocal cord paralysis may cause hoarseness, inadequate respiration, delayed bottle feeding and recurrent aspiration, which did not occur in our infant.

References

1. Anderson RC. Causative factors underlying congenital heart malformations I, patent ductus arteriosus. *Pediatric* 1954;14: 43-51.
2. Carlgren LE. The incidence of congenital heart disease children born in Gotenberg 1941-1950. *Br Heart J* 1959;21:40-50.
3. Mitchell SC, Korones SB, Berendes HW. Congenital heart disease in 56,109 births. Incidence and natural history. *Circulation* 1971;43:323-32.
4. Fyler DC, Buckley LP, Hellenbrand W, et al. Report of the New England Regional Infant Cardiac Program. *Pediatrics* 1980;65:375-461.
5. Lake CL. *Pediatric Cardiac Anesthesia*. 2nd ed. Norwalk: Appleton & Lange; 1993. p. 363.
6. Kaplan J. *Cardiac Anesthesia*. 4th ed. Philadelphia: WB Saunders; 1999. p. 807.
7. Stehling L. Common problems in Pediatric Anes-

- thesia. 2nd ed. St. Louis: Mosby, 1992. p. 49
8. Moore P, Brook MM, Heymann MA. In: Allen HD, Gutgesell HP, Clark EB, editors, Patent Ductus Arteriosus (6th edn.). Moss and Adam's Heart Disease in Infants, Children, and Adolescents Including the Fetus and Young Adults vol. 1, Lippincott Williams & Wilkins: Philadelphia; 2001. p. 652-69.
 9. Soll RF. Prophylactic natural surfactant extract for preventing morbidity and mortality in preterm infants. Cochrane Database of Systematic Reviews 2 (2000), p. CD000511.
 10. Lipman B, Serwer GA, Brazy JE. Abnormal cerebral hemodynamics in preterm infants with patent ductus arteriosus. *Pediatrics* 1982;69:778-81.
 11. Heyman MA. Patent ductus arteriosus. In: Adams FH, Emmanouilides GC, editors. Moss' Heart Disease in Infants, Children, and Adolescents. 3rd ed. Baltimore: William & Wilkins; 1983. p 158-171
 12. Barst RJ, Gersony WM. The Pharmacological Treatment of patent ductus arteriosus: A review of the evidence. *Drug* 1989;38: 249-66,33.
 13. Dooley KJ. Management of the premature infant with a patent ductus arteriosus. *Ped Clin North Am* 1984;31:1159-74.
 14. Clyman RI, Heymann MA. Pharmacology of the ductus arteriosus. *Ped Clin North Am* 1981;28:77-94.
 15. Fitzgerald M, Millard C, MacIntosh N. Hyperalgesia in premature infants. *Lancet* 1988;1:292.
 16. Andrews K, Fitzgerald M. The cutaneous withdrawal reflex in human neonates: sensitization, receptive fields, and the effects of contralateral stimulation. *Pain* 1994;56:95-101.
 17. Grunau RE, Oberlander TF, Whitfield MF, et al. Demographic and therapeutic determinants of pain reactivity in very low birth weight neonates at 32 weeks' postconceptional age. *Pediatrics* 2001;107: 105-12.
 18. Harte GJ, Gray PH, Lee TC, et al. Haemodynamic responses and population pharmacokinetics of midazolam following administration to ventilated, preterm neonates. *Journal of Paediatrics and Child Health* 1997;33:335-8.
 19. Lee TC, Charles BG, Harte GL, et al. Population pharmacokinetic modeling in very premature infants receiving midazolam during mechanical ventilation: midazolam neonatal pharmacokinetics. *Anesthesiology* 1999;90:451-7.
 20. Massone ML, Soliani M, Puccio V, et al. The relationship between ligation of the ductus arteriosus and intracranial hemorrhage in preterm infants. *Minerva Anestesiologica* 1990;56: 179-83.
 21. Fan LL, Campbell DN, Clarke DR, et al. Paralyzed left vocal cord associated with ligation of patent ductus arteriosus. *Journal of Thoracic and Cardiovascular Surgery* 1989;98:611-3.
 22. Zbar RI, Chen AH, Behrendt DM, et al. Incidence of vocal fold paralysis in infants undergoing ligation of patent ductus arteriosus. *Annals of Thoracic Surgery* 1996;61:814-6.

การให้การระงับความรู้สึกในทารกแรกเกิดที่คลอดก่อนกำหนดและมีน้ำหนักตัวน้อยมาก (710 กรัม) ที่มาผ่าตัด ligation of patent ductus arteriosus

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บทคัดย่อ

วัตถุประสงค์ การให้การระงับความรู้สึกเพื่อผ่าตัดในทารกแรกเกิดที่คลอดก่อนกำหนดต้องพึงระวังภาวะแทรกซ้อนต่างๆ เป็นอย่างมาก โดยเฉพาะหากทารกมีน้ำหนักตัวน้อยมากๆ อีกทั้งยังมีปัญหาทางระบบไหลเวียนโลหิตอย่างรุนแรง

ทารกแรกเกิดเพศหญิงที่คลอดก่อนกำหนดเมื่ออายุครรภ์ 29 สัปดาห์ โดยวิธีผ่าตัดคลอดเนื่องจากถุงน้ำคร่ำมารดาแตกก่อนกำหนด น้ำหนักแรกคลอด 820 กรัม หลังคลอดปรากฏอาการ infant respiratory distress syndrome ได้ใส่ท่อช่วยหายใจทันที หลังจากตรวจโดยละเอียดที่หอผู้ป่วยวิกฤตทารกแรกเกิดแล้วพบว่ามี severe patent ductus arteriosus และการทำงานของไตล้มเหลว ไม่สามารถปิด ductus arteriosus ได้ด้วยยา จึงต้องผ่าตัดเมื่ออายุ 6 วัน น้ำหนักตัวเพียง 710 กรัม โดยทั้งระหว่างการเคลื่อนย้ายทารกและในห้องผ่าตัด ได้ควบคุมอุณหภูมิ ช่วยหายใจ และติดตามสัญญาณชีพอย่างต่อเนื่อง ได้สอดสายน้ำเกลือที่ antecubital veins ทั้งสองข้างและสอดสายตรวจความดันโลหิตอย่างต่อเนื่องที่ femoral artery ตรวจคลื่นไฟฟ้าหัวใจ ความดันโลหิต ค่า oxygen saturation ทั้งก่อนและหลังต่อ ductus arteriosus ค่าคาร์บอนไดออกไซด์ในลมหายใจออก และอุณหภูมิอย่างต่อเนื่อง นำสลบด้วย fentanyl 1 มก. atropine 0.015 มก. atracurium 0.5 มก. และ ketamine 1.0 มก. แล้วจึงสอดสายอาหารสู่กระเพาะอาหาร สอดสายเพื่อฟังเสียงหัวใจสู่หลอดอาหาร และสายสวนปัสสาวะ ควบคุมระดับออกซิเจนและ sevoflurane ช่วยหายใจโดยใช้อุปกรณ์ Jackson Rees circuit และจัดท่านอนตะแคงหันไปทางขวาเพื่อผ่าตัดผ่านทางทรวงอกด้านซ้าย

สรุป การเข้าใจระบบไหลเวียนโลหิตคือหัวใจสำคัญของการให้การระงับความรู้สึกแก่ทารกนี้โดย 1) ระวังสัดส่วนออกซิเจนในบรรยากาศที่ให้แก่ทารกไม่ให้มากเกินไป 2) การควบคุมระบบไหลเวียนโลหิตให้คงที่ 3) การป้องกันการสูญเสียความร้อนเพื่อหลีกเลี่ยงภาวะ hypothermia เชียงใหม่เวชสาร 2548;44(4):155-160.

คำสำคัญ: anesthesia, preterm, low birth weight, PDA ligation