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What Really Matters For A Preterm Infant Undergoing Ventriculo-Peritoneal Shunt Surgery– A Case Report And Review Study

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Abstract
Preterm neonates show the unique challenges to the anesthesiologist and dealing surgeon due to their immature physiology and anatomy. Many preterm neonates can expose for anaesthesia, those schedule for various surgical procedures. Anesthesiologists play a vital role in the management of preterm neonates requiring surgical interventions, by integrating their knowledge of the developmental physiology and pharmacology. Extreme care should be taken when these preterm neonates posted for neurosurgical interventions. The successful conduct of anesthesia in premature neonates requires an understanding of the basic principles of neonatal care.

Background

Globally over 13 million babies are born as preterm every year. The rate of preterm birth in India is approximately 21%.[1]

Although recent advances in medical technology, diagnostic modalities and neonatal intensive care have improved survival, but mortality is still approximate 42 per 1000 live births compared with 1.8 per 1000 in term babies even in developed countries.[2]

These survivor neonates can present for variety of surgeries for different types of congenital anomalies.

In ancient era, it was thought that due to the immaturity of the nervous system, these preterm babies do not experience pain. Recent work has proved that as early as the 13th to 20th week of gestation, there is perception of pain. Evoked potentials and cerebral glucose metabolism offer evidence of functional maturity and responses such as changes in pulse and blood pressure, crying, and grimacing have been quantified for circumcisions done without anaesthesia.[3]

Here we are presenting about a successful peri-operative management of a 7th weeks aged preterm infant {Gestational age 27 week}; who was operated for ventriculo-peritoneal shunt surgery. Here we covered most of anaesthesiological and physiological consideration regarding pre-term babies for ventriculo-peritoneal surgery.

Case Study

A 7 weeks aged preterm infant received from neonatal intensive care (NICU) operation theatre for ventriculo-peritoneal surgery after proper pre-anaesthetic check-up and optimization. Platelets were transfused before surgery because of low platelet count and risk of peri-operative haemorrhage in this preterm infant.

After going through her medical history and examination we found that this female child delivered by elective caesarian section at the gestational age of 27 weeks; that was already, diagnosed hydrocephalus by fetus ultrasonography. The maternal history was quite unremarkable for any prenatal infections, drug abuse or any other chronic disease. No significant obstetric or family history was elicited. After proper oxygen therapy, nasal CPAP and 12 days neonatal intensive management she discharged to home. Presently, she was brought with the complaints of continuous increase in her head size. On examination, she found little dull but was opening of her eyes and moving all limbs actively on light touch stimulus. Her weight was 2250gm, head circumference was 45 cm, had a bulging and tense anterior fontanellae and sun set sign was too positive. Her base line heart rate was 136 beats/min and respiratory rate 28 breaths/min. Her investigations revealed Hb 10.6 gm%, while platelets count of 58 x 10^9/L before platelets transfusion. Her brain's CT showed the massive enlargement of the lateral ventricles with a rim of brain tissue lining the anterior calvarium, an enlarged third ventricle and an enlarged CSF space in the dorsal midline posterior fossa. There were no signs of cardiovascular and respiratory pathology. Fortunately she was free from other congenital anomalies of preterm like menningomyelocoele, tracheo-oesophageal fistulas, ano-rectal anomalies etc. Platelets were transfused prior to surgery.

The ambient OT temperature maintained approximately 27 C. Hot water bottle, warm sheets and blankets were used to minimizing the heat loss. Appropriate 000 sized face mask, small laryngoscope with miller's straight blade, 2.5 mm and 3.0 mm sized endotracheal tube with stylets, Jacksons Rees breathing circuit and adequate sized, venous canula, suction catheter, suction apparatus at desired setting, and other resuscitation things like AMBU etc. were rechecked.

In the operating theatre, her pre-operative vital signs were; HR-132 beats/min, and SpO_2-99% at room air. A difficult intubation was anticipated in view of very large head as compare to her body, therefore a meticulous preparation was done for same, including different types of laryngoscope blades and LMA. Patient was placed on OT table over warm mattress and one roll of few sheets was also placed under her back for making easy for intubation. The head was also fixed in position by means of small rolled sheets on each side. She was pre-medicated with intravenous inj. Glycopyrolate 0.04mg, inj. Midazolam 0.1mg and inj. Fentanyl 5 mcg.

Preoxygenation was done for 5 min and anaesthesia was induced with thiopentone sodium 10 mg. Inj. succinylcholine 5mg given after checking the mask ventilation and oral intubation was done with 2.5 mm uncuffed endotracheal tube. Bilateral air entry was confirmed and secured the tube. Inj. atracurium 1.5 mg bolus was given for adequate muscle relaxation. Anaesthesia was maintained itraoperatively with isoflurane in 50% O_2 and N_2O. Ventilation was controlled with an inspiratory pressure set around 10 cm H_2O and a respiratory rate of 30 breaths/min. The whole course of anaesthesia remained uneventful. At the end of the procedure, patient was reversed with inj. neostigmine 0.1mg IV plus inj.atropine and was extubated after giving paracetamol suppository. She became conscious with good respiratory efforts postoperatively, with HR-136 beats/min and SpO2 -100%. She was shifted to NICU and kept there for observation for 36 hrs, remained haemodynamically stable. Than she was shifted to ward, where neonatologist managed her in views of vitals monitoring, general care, nutritional, fluid and electrolytes.

Discussion

The Physiology of the preterm and ex-preterm neonate is quite immature; that's why these patients present a great challenge to the anaesthesiologist, neurosurgeon and neontologist. The various physiological factors that increase morbidity and mortality in these patients are usually consequent to the immaturity of the various body systems and the associated congenital defects.

Preanaesthetic Evaluation

Preoperative assessment should include parental consultation with the description of a likely deterioration in pulmonary function necessitating postoperative ventilatory support. The infant's antenatal history, gestational age, and weight are prerequisite information for surgical procedures.[4] A detailed complete system examination should be carried out with special reference to upper airway appearance and possibility of difficult intubation.

The routine investigations - Haemoglobin, haematocrit, platelets, and the coagulation profile should be within acceptable limits. Preoperative serum electrolyte and glucose levels will help guide requirements in theatre. An ABG, X-ray chest and an echocardiogram are desirable prior to surgery. Cross-matched blood must be available so that transfusion can be given whenever the blood loss is more than 10% of blood volume during the surgery.[5]

Periods of preoperative fasting must be taken into account to calculate fluid deficits that need replacement intraoperatively. Neonates undergoing elective surgery can be fed until 4 hours before anaesthesia and then given clear fluids until 2 hours before surgery. Breast milk and Formula feeds are considered in the same category as solids.[6] If surgery is delayed for ex-tended periods, IV fluids must be given, or if time permits, additional clear oral fluids are given. Some babies may be receiving total parenteral nutrition to provide their maintenance fluid, glucose, and electrolyte requirements. A detailed pre-anaesthetic check should be performed with special reference to detection and correction of fluid and electrolyte deficits.

Premedication is usually avoided as there may be a dramatic respiratory depressant response to the drugs. However, atropine (10–20 mcg/kg) can be considered for bradycardia.

Practical Points for the conduct of anaesthesia in a preterm neonate

Some modifications for the conduct of anaesthesia may be required for these very tiny infants.

In infants, clinical findings of increased ICP are non-specific, such as vomiting, lethargy, irritability, bulging fontanelle, and poor feeding, so it may be difficult to determine preoperatively if an infant has increased ICP. These patients are also at risk of vomiting and pulmonary aspiration.[7] Preparation for elevated ICP should always be undertaken, including avoidance for hypercarbia and hypoxia, treatment of hypotension, hyperventilation, elevating of the head end of OT table, avoidance of PEEP to prevent venous congestion and administration of mannitol and osmotic agents. Brain stem distortion and hydrocephalus can result in bradycardia, hypertension and change in respiratory rate, and the anaesthesiologist should be prepared for immediately respond to these changes.

Monitoring

SpO_2: Two pulse oximeters should be used; the first saturation probe is placed on the right hand (pre-ductal) and the other on a lower limb (post-ductal). These oximeters should be of the neonatal variety, with less adhesive to minimize skin damage.

Blood Pressure: Proper size and application is important since repeated noninvasive blood pressure measurement can fracture very poorly ossified, calcium deficient bones. The definition of a normal systemic blood pressure is problematic in the extremely low gestational age newborn. A safe rule of thumb is to treat the mean arterial blood pressure if it is below the gestational

age + 5 mm Hg. Treatment options are variable and include IV fluid, or vasopressors.[8,9]

ECG: Adhesive on electrocardiogram (ECG) stickers can damage the skin. Removal of adhesive tape or monitors can damage the skin akin to a partial thickness burn. After delivery, the skin of preterm newborns does mature rapidly and achieves greater thickness within a few weeks.

EtCO2: Because of very small tidal volumes and low maximum expiratory flow rate, end-tidal CO2 measurement will be rendered less accurate but is important nonetheless.[8]

Temperature monitoring: It is important and intra oeso-phageal temperature can be monitored using a combined stethoscope and temperature probe. But this may itself pose a risk as sometimes perforation is possible despite meticulous and careful placement of rectal or esophageal probes.[8]

IBP: Invasive blood pressure or central venous pres-sure measurement, although desirable, is so technically challenging and potentially dangerous that often these are not employed. If an umbilical artery line is in place, rapid sampling and flushing can lead to disastrous con-sequences.[8]

OT Preparation

Staffing: Extra personnel and help may be required. An experienced operating department practitioner is essential.

Equipments: All equipment including a Mapleson-F circuit for hand ventilation, anaesthetic machine, ventilator, breathing circuits, infusion pumps, and laryngoscopes should be pre-checked. Electrical supply for infusion pumps must be assured, especially if inotropic support is to be continued. A pressure controlled ventilator capable of delivering small tidal volumes with PEEP is quite essential.

Airway: Securing the airway is difficult in these very tiny babies and proper-sized equipment and endotracheal tubes and masks should be available and ready. These patients generally arrive to the OT already intubated, thus the anaesthetic plan should include post-operative mechanical ventilation. A —000 face mask, —0 Miller blades and 0-sized laryngeal mask airways (LMAs) should be available, as well as endotracheal tubes of 2.5, 3.0 and 3.5 mm outer diameter (OD) with appropriately sized stylets.

OT temperature: Premature infants have a greater tendency for heat loss. The ambient OT temperature must be kept around 27 C. Patient should be kept warm by using a warming mattress and a warm air blanket. Inspired gases should be heated and humidified with a paediatric heat-moisture exchanger. I.V. fluids, blood, and blood products should be warmed and used. Irrigation fluid must be warmed. Other ways to keep the patient warm include application of the waterproof surgical drape to the non-involved areas.

Positioning: The majority of preterm neonates requiring emergency surgery are likely to be intubated and ventilated and transported in a dedicated transfer incubator. The preterm baby must be carefully but expeditiously transferred to the operating table taking care to avoid accidental disconnections and decannulations.

General anaesthesia

The advantages of general anaesthesia (GA) are better control over the respiratory and cardiovascular parameters.

There is considerable controversy currently over the long-term CNS effects of many anaesthetic medications such as midazolam, nitrous oxide, isoflurane and ketamine. There have been reports of choreaform movements with long-term administration of midazolam in newborns, and for this reason many NICUs no longer use this medication to sedate preterm newborns receiving mechanical ventilation.[8,9]

Moderate concentrations of volatile agents can be used to minimize increase in PVR and to avoid decrease in systemic arterial pressure. Also inhaled nitric oxide can be used for the same. Although halothane has shown to cause postoperative complications, the newer shorter acting agents, desflurane may be particularly

useful for recovery in a preterm infant prone for respiratory depression and apnoea.[5,10,11]

Rapid sequence inductions can be challenging as even a short period of apnoea can cause detrimental desaturations, and mechanical pressure over the cricoid area can render the anatomy unrecognizable. Its use in children is questioned in contemporary practice. The tracheal length is 4 cm in a preterm neonate; there-fore, the tube length should be carefully adjusted and secured. As a guide 1, 2, 3, and 4 kg babies should have the TT positioned at the gum margin at the 7, 8, 9, and 10 cm marks. The TT should allow a positive pressure breath with a small leak at 20–25 cm H2O pressure. Opioids have a long record of safety in pre-term and fentanyl is advised as part of balanced anaesthesia in those with potential or overt pulmonary hypertension on ventilator therapy.[5,12,13]

There is concern that even brief exposure to high oxygen levels is associated with increased morbidity and mortality in premature infants; fluctuations in oxygen levels should be avoided and oxygen saturation maintained between 88-95%, not exceeding 95%. Newborn resuscitation should be carried out with room air rather than 100% oxygen.[14]

Tachycardia and hypertension can be detrimental in the presence of underdeveloped cerebral auto regulation. And hence careful titration of anaesthetic and narcotic analgesic agents is necessary. For those who will be extubated after operation, minimal use of opioids combined with local anesthetic techniques and acetaminophen is beneficial, while planned postoperative ventilation indicates an opioid-based technique.

In these patients, hypoglycemia should be anticipated and managed accordingly at a rate of 8 to 10 mg/kg/minute. This can be achieved by administering 10% dextrose at a rate of 110 to 120 ml/kg/day.[15] Glucose levels should be checked frequently, either by finger-stick using a glucometer or as part of an arterial blood gas measurement.

The blood volume of an 800-g newborn is 95 to 100 ml. Even what appears to be a small amount of bleed-ing is significant to such a small patient. Replacement of blood products must be done promptly but also slowly.[16,17] A 10-mL syringe of packed cells (PBRC) rapidly delivered into the vascular system over <1 minute will increase the blood volume by 10%. This is analogous to administering 2 units of PRBC to an adult over 1 minute. It is also very important that the blood products be warmed to minimize hypothermia in these patients.

Post Operative Analgesia

The aims of postoperative analgesia are to recognize pain, to minimize moderate and severe pain safely, to prevent pain where it is predictable, to bring pain rapidly under control and to continue pain control after discharge from hospital.[18] Pain is prevented using multi-modal analgesia, based on four classes of analgesics, namely local anaesthetics, opioids, non-steroidal antiinflamma-tory drugs (NSAIDs), and acetaminophen.

Opioids, because of their dramatic response on the respiratory system and tendency to cause postoperative apnoea, are not recommended for post operative analgesia in preterm and ex-preterm neonates. Local anaesthetics, NSAIDs, and acetaminophen are generally preferred. However, most NSAIDS are not suitable for use in infants less than 6 months of age. Paracetamol is the only analgesic that can be safely used for postoperative analgesia in preterm infants.[18,19]

Conclusion

The knowledge of cerebral pathophysiology and impact of surgical stress as well as anaesthetic agents on preterm brain is essential for peri-opearative management of such preterm babies undergoing neurosurgery.

Disclosure

Institutional ethical board approval was obtained for this case report and the patient's mother consented to publication. There was no funding

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