Original Article

Perioperative management and post-operative course in preterm infants undergoing vitreo-retinal surgery for retinopathy of prematurity: A retrospective study

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Abstract

Background: Premature infants scheduled for surgery under general anesthesia are more prone to cardio-respiratory complications. Risk factors include post-conception age (PCA), cardiac and respiratory disease, anemia and opioid administration. This retrospective study evaluates the perioperative management and post-operative course (apnea and bradycardia) in premature infants undergoing surgery for retinopathy of prematurity (ROP).

Materials and Methods: We analyzed the pre-operative data, anesthesia chart and post-operative course of 52 former premature infants for 56 general anesthesia exposures for ROP surgery.

Results: At the time of procedure, median PCA was 51 (36-60) weeks. 71% of the infants were above 46 weeks of PCA. Five infants had cardiac disease and four had a history of convulsion. Four infants had a pre-operative history of apneic spells. The airway was secured with either endotracheal tube (46) or supraglottic device (10). Fentanyl (0.5-1 μg/kg), paracetamol, topical anesthetic drops and/or peribulbar block were administered for analgesia. Extubation was performed in the operating room for 54 cases. Three infants had apnea post-operatively. Seven infants were shifted to neonatal intensive care unit either for observation or due to delayed recovery, persistent apneic spells and pre-existing cardio-respiratory disease.

Conclusion: In the present study, intravenous paracetamol and topical anesthetics reduced the total intra-operative opioid requirement, which resulted in low incidence of post-operative apnea. Regional anesthesia may be considered in infants with high risk of post-operative apnea. Infants with PCA > 42 weeks and without any co-morbidity can be managed in post-anesthesia care unit.

Key words: Anesthesia, neonatal intensive care, post-operative apnea, post-operative monitoring, preterm infants, retinopathy of prematurity

Introduction

Retinopathy of prematurity (ROP) is a potentially blinding eye disorder that primarily affects premature infants weighing less than 1250 g and/or those born before 31 weeks of gestation. The number of former preterm infants presenting for various surgical and non-surgical procedures for ROP has increased over past few years with 16-48% incidence.[1-3]

The International classification of ROP[4] classified ROP in five stages ranging from mild (Stage I) to severe (Stage V). Early intervention is needed for good visual outcome. Laser photocoagulation is done in ROP Stage III.[5] Scleral buckling and lens sparing vitrectomy are performed in ROP Stage IV while vitrectomy is performed in ROP Stage V.

There are many case reports about anesthetic management and post-operative course of preterm infants for laser photocoagulation;[6] however same for ROP Stage IV and V is limited. Post-operatively, these infants are usually transferred to neonatal intensive care unit (NICU) in view of risk of apnea and bradycardia.

In our institute, ROP surgeries are being performed for past few years, hence, we planned a retrospective study to evaluate

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the perioperative anesthetic management, post-operative course including incidence of post-operative apnea and need for NICU monitoring in preterm infants after vitreo-retinal (VR) surgery.

Materials and Methods

In this retrospective study, after the Ethics Committee clearance, we collected and reviewed the case files of 54 infants, who underwent surgery for ROP from January 2008 to December 2011. Pre-anesthetic assessment sheets were reviewed and information regarding birth history, requirement of NICU, mechanical ventilation, oxygen supplementation, presence of syndromes, medication history, gestational age (GA) at birth and post-conceptual age (PCA), sex, weight, airway evaluation, previous surgical procedures, pre-operative advice (nil per oral orders and premedication) was retrieved. Anesthesia charts were reviewed for information regarding induction technique, airway management, analgesic modalities, perioperative adverse events and need for post-operative monitoring in post-anesthesia care unit (PACU)/NICU and/or ventilation. All these data were tabulated and subsequently analyzed.

Results

Out of 54 infants, data of two children were not analyzed as their age at the time of surgery was more than 60 weeks PCA. Final data of 52 former preterm infant (PCA < 60 weeks) were further analyzed. Two infants underwent surgery thrice and details of the anesthesia were tabulated separately (56 anesthesia exposures).

Patient characteristics and perinatal history are depicted in Tables 1 and 2 respectively. Median GA was 28 (26-35) weeks; PCA at the time of surgery was 51 (36-60) weeks. Median duration of surgery was 52 (15-120) min and duration of anesthesia was 90 (30-200) min. Birth weights of infants were between 800 and 1800 g.

20 infants had a previous history of anesthesia exposure (ophthalmic procedures [18], intestinal obstruction [1] and patent ductus arteriosus [PDA] ligation [1]). Four infants had undergone laser photocoagulation without general anesthesia or sedation (details not known).

Motor and social milestones were delayed in three cases. There were no obvious syndromes and physical anomalies present in any of the case except retrognathia (4/52) and microcephaly (1/52). Two infants had PDA (duct ligation [1], uncorrected [1]) and one had atrial septal defect (ASD). Four infants had

Table 1: Patient characteristics

Demography	Male (n = 38)	Female (n = 18)
Gestational age at birth		
24-30 weeks	36	15
31-36 weeks	2	3
Post-conceptual age at the time of procedure		
<42 weeks	5	2
42-46 weeks	3	6
46-60 weeks	30	10
Weight at the time of procedure		
<3 kg	5	2
3-6 kg	25	14
>6 kg	8	2

n = Number of infants

Table 2: Post natal course of former preterm infants

Post natal course	Number of infants
NICU admission	51
Oxygen requirement	49
Mechanical ventilation	32
Sepsis/jaundice	15
Apneic episodes	10
Seizure	9
Cyanosis	2

NICU = Neonatal intensive care unit

a pre-operative history of apneic spell and among these four infants; one had a history of cyanosis during apneic spell and required tactile stimulation to resume breathing. Four children had a history of seizures and were on anticonvulsants.

Pre-operative hemoglobin ranges from 7.0 to 12.9 (median 10.6) g%. Echocardiography report was available with three cases (small ASD [1], moderate PDA [1] and corrected PDA [1]) and was ordered in three cases. Patent foramen ovale was confirmed in three cases of them.

Pre-operative orders by Anesthesiologists consisted of fasting orders and anticonvulsant medications (phenytoin, clonazepam, phenobarbitone, sodium valproate). Arrangements were made in the NICU or pediatric intensive care unit (PICU) for post-operative monitoring in each case. About 53 infants underwent (VR) surgery and three infants underwent scleral buckle removal.

In the operating room (OR), electrocardiogram (ECG), pulse oximetry (SpO_2), non-invasive blood pressure, end tidal carbon dioxide ($EtCO_2$), temperature and blood sugar were monitored. General anesthesia was induced with sevoflurane (50), halothane (4) or thiopentone (2) with 100% oxygen (O_2), assisted ventilation was possible in all cases.

Atracurium was administered to facilitate endotracheal intubation and controlled ventilation with closed circuit was

instituted in 54 cases. In two infant, the trachea was intubated without muscle relaxant under spontaneous ventilation with sevoflurane. No anticholinergic drugs were used in any of the case before induction. One infant had bradycardia at induction; another had bradycardia after administration of neuromuscular blocking agent. Atropine was administered intravenously in both these cases.

The airway was secured with either an endotracheal tube (ETT) (46/56) or supraglottic airway (SGA) devices (10/56) [Table 3]. In one child, four attempts were needed for endotracheal intubation. A combination of nitrous oxide (N_2O) and O_2 (FiO_2 0.5) was used for controlled ventilation in all except three cases, where air and O_2 was used as there was a pre-operative plan of intravitreal gas injection. A proseal laryngeal mask airway (LMA) was replaced with an ETT in one case before the start of surgery. In another case, a classic LMA was slightly displaced intra-operatively, however device reinsertion was not required as $EtCO_2$ was maintained between 45 and 48 mmHg in spite of decrease in tidal volume.

Fentanyl (0.5-1 μg/kg) was used in all cases except three for perioperative analgesia and was supplemented by either topical local anesthetics (2% lignocaine gel [15], 0.5% proparacaine drops [36]) or peribulbar block (3) and paracetamol (rectal suppository [27], intravenous [17]). There was no reporting of oculocardiac reflex or other intra-operative complications except T wave inversion with a decrease in heart rate to <130/min with normal mean arterial blood pressure in one case.

All infants were operated as a first case in the list and lactated ringer solution was administered along with blood glucose monitoring intra-operatively. None of the infants required glucose supplementation in the OR. Apart from warming the OR, a radiant warmer was used during the induction and reversal of anesthesia and oropharyngeal temperature was monitored.

Table 3: Airway devices and analgesia for ROP surgery

Airway device and analgesia	Number of infants
Airway devices	
Endotracheal tube	46
LMA-proseal	3
LMA-classic	4
LMA-flexometallic	2
Cobra-PLA	1
Peri-operative analgesia	
Fentanyl	53
Paracetamol (rectal/intravenous)	44 (27/17)
Topical 0.5% proparacaine eye drops	36
Topical 2% lignocaine gel	15
Peribulbar block	3

LMA = Laryngeal mask airway, PLA = Perilaryngeal airway, ROP = Retinopathy of prematurity

At the end of surgery, residual neuromuscular blockade was reversed with neostigmine and atropine. All infants except two were extubated in the OR. 50 infants were shifted to PACU for monitoring by Anesthesiologist and recovery nurse and six infants were shifted to NICU/PICU [Table 4] for further observation. One infant (42 weeks PCA) developed apnea and cyanosis in PACU 2 h after VR surgery. Tactile stimulation and bag mask ventilation was instituted, resulting in normal respiration after 10 min and subsequently shifted to NICU for monitoring. He did not require further O_2 supplementation in NICU and was discharged after 2 days. Post-operatively SpO_2, ECG and respiration was monitored in NICU/PACU.

Post-operative analgesia was provided by oral paracetamol. Two infants developed mild fever during the post-operative period and none had hypoxia or required reintubation or had any major post-operative complications in the ward.

Discussion

Post-operative cardio-respiratory complications are the main concerns for preterm infants scheduled for surgery under general anesthesia. In the present study, incidence of post-operative apnea after ROP surgery was 5.36% which is less than reported incidence of 31-36% after herniotomy in preterm infants.[7] The incidence of apnea may vary with different anesthetic techniques and study population (strongly and inversely related to both GA and PCA).[8] Presence of other associated risk factors like apnea at home, large for GA infants, anemia in infants with PCA >43 weeks, neurological disease or chronic lung disease (CLD) also contribute for post-operative apnea incidence.[9-10]

Preterm infants are very sensitive to the respiratory depressant effect of opioids, which may lead to delayed recovery as happened in one case in the present study. In another study, when fentanyl was administered at a mean dose of 4.6 mcg/kg for vitrectomy in ROP, 6/29 infants required post-operative ventilation for more than 2 days.[11] Drugs with very short duration of action like remifentanil may reduce the apnea incidence.[12] In the present study, multimodal analgesia was used to reduce opioid requirement. Among 56 infants, 40 infants received fentanyl, paracetamol and topical anesthesia. Five infants received fentanyl and topical anesthesia. Two infants received fentanyl and paracetamol and six infants received only fentanyl. Fentanyl was administered at the dose of 0.5-1.0 mcg/kg and was omitted in three cases with a history of respiratory difficulty. One had a pre-operative history of breath holding spells; second infant had post-operative delayed recovery during previous anesthesia and

Table 4: Details of the infants who were shifted to NICU after vitreo-retinal surgery

Patient	GA (weeks)	PCA (weeks)	Weight (kg)	NICU stay	Risk factors of post-operative apnea	Complications after vitreo-retinal surgery
Case I	28	41	2.7	37 days sepsis, jaundice	Mechanical ventilation-7 days Supplemental oxygen Seizure Haemoglobin-8 g%	Trachea extubated in OR, shifted electively to NICU for monitoring (initial case)
Case II	28	40	3.0	45 days	Mechanical ventilation-30 days Supplemental oxygen-45 days	Trachea extubated in OR, shifted electively to NICU for monitoring (initial case)
Case III	28	42	3.6	12 days	Mechanical ventilation-7 days Supplemental oxygen	Trachea extubated in OR, shifted electively to NICU for monitoring (initial case)
Case IV	30	42	3.5	50 days	Mechanical ventilation-2 days Supplemental oxygen Apnea at home caffeine administration	Delayed recovery, trachea extubated in OR, shifted to NICU for monitoring
Case V	26	36	2.0	30 days sepsis, jaundice	Mechanical ventilation-5 days Supplemental oxygen Seizure	Two episodes of apnea for 5-10 s after 20 min of reversal of neuromuscular blockade Trachea not extubated and Shifted to NICU for mechanical ventilation
Case VI	26	38	2.0	45 days sepsis	Hyaline membrane disease Mechanical ventilation-30 days Supplemental oxygen Apnea in home Hemoglobin-9 g% Moderate PDA	Apneic episodes after reversal of residual neuro-muscular blockade, shifted to NICU without extubation
Case VII	27	42	3.0	60 days sepsis	Hyaline membrane disease Mechanical ventilation-30 days Supplemental oxygen Apnea and cyanosis at home	Apnea and cyanosis 2 h after surgery in PACU, Resolved with tactile stimulation and bag mask ventilation, shifted to NICU for monitoring

GA = Gestational age, PCA = Post-conceptual age, OR = Operating room, NICU = Neonatal intensive care unit, PACU = Post-anesthesia recovery room, PDA = Patent ductus arteriosus

third had apnea and bradycardia in PACU 2 h after surgery. These infants received peribulbar block and two of them also received paracetamol and had uneventful post-operative course.

Preterm infants <46 weeks should be admitted for monitoring for at least 12 h post-operatively. First episode of apnea usually occurs within the first 4 h post-operatively so monitoring for 6 h may be sufficient for the infants between 46 and 60 weeks.[13] In the present study, 30.5% infants were <46 weeks of PCA. After initial three cases, we monitored all the infants above 42 weeks PCA whose trachea was extubated in the PACU for 6-12 h and in case of the problem in PACU they were shifted to NICU/PICU.

Though endotracheal intubation may be difficult due to subglottic stenosis with history of prolonged intubation, it was preferred in the present study as post-operative ventilation can be continued if required. General anesthesia with ETT has been reported to provide more stable intra-operative course than sedation and topical anesthesia for laser therapy.[14] SGA has many advantages in ophthalmic surgery,[15] but intra-operative displacement may lead to hypoxia and ocular infection. Displacement of SGA was observed in 2 out of 10 cases in the present study.

As there are limited beds in NICU in our institute, not all infants but only infants with PCA <42 weeks or with associated risk factors were shifted to NICU. The seven infants (12.5%) were shifted to NICU in the present study. Two infants were shifted for post-operative ventilation (PDA with pre-operative history of recurrent apnea [1], apneic episodes after reversal of neuromuscular blockade [1]). Trachea was extubated within 30 min in both the infants in NICU. Five infants were transferred to NICU for monitoring (initial cases-3), delayed recovery (1) and apnea and bradycardia in PACU (1). Delayed recovery can be due to a number of factors i.e. hypothermia, hypoglycemia, residual effects of anesthetic drugs and electrolyte imbalance. In this study, there was no increase in the incidence of apnea in infants with anemia, seizure or CLD.

Post-operative monitoring in the PACU should include ECG, pulse oximetry and respiration along with observation by Anesthesiologist and nurse to handle emergencies. In this study, preterm infants were taken for surgery as the first case and infants between 42 and 60 weeks without any co-morbidity were monitored in the PACU post-operatively for 6-12 h and if needed shifted to NICU as suggested by Walther-Larsen and Rasmussen.[13]

Limitations of the present study include its retrospective nature as some information regarding perioperative management might be not recorded in the anesthesia charts and lack of discharge summary of NICU stay after birth in many infants.

Hence to conclude, we observed a lower incidence of postoperative apnea in preterm infant undergoing VR surgery for ROP. This may be attributed to reduced doses of intra-operative opioids with the use of paracetamol and topical anesthetics. Regional anesthesia along with general anesthesia may be considered in infants with high risk of post-operative apnea. Considering only 12.5% of infants required NICU/PICU admission post-operatively, the authors suggest that most infants with PCA >42 weeks can probably be observed and managed in a well-equipped PACU.

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