Original Article

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Apneas in Infants with Postconceptional Age bellow 60 Weeks Undergoing Herniorrhaphy

Mohamad Gharavi-Fard, MD; Mehryar Taghavi-Gilani, MD; Samira Kazemi, MD; Majid Razavi*, MD

Cardiac Anesthesia Research Center, Imam-Reza Hospital, School of Medicine, Mashhad University of Medical Science, Mashhad, Iran

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Abstract

Objective: Postoperative apnea is a major concern in infants undergoing surgery. In this study, we evaluated incidence and related factors for postoperative apnea in infants less than 60 weeks postconceptual age after herniorrhaphy.

Methods: One-hundred fifty infants with post conceptional age (PCA) less than 60 weeks who underwent elective herniorrhaphy were studied over eight months in 2012. General anesthesia was induced by sevoflurane and maintained by remifentanil, atracurium, and N_2O 60%. Postoperatively, they were monitored for two hours in the recovery room and ten hours in the ward using pulse oximetry and nasal capnography.

Findings: Totally, 31 (20.7%) cases of postoperative apnea were reported. By comparing the patients, factors associated with postoperative apnea included postconceptional age, birth weight, and history of apnea, oxygen therapy, metabolic diseases, icterus, or cardiac disease. Twenty-seven (18%) apnea cases occurred in recovery room in infants with gestational age (GA) of 35.64±2.73 weeks, while only four (2.6%) patients of GA 36.02±2.0 weeks developed delayed apnea).

Conclusion: In our study, the incidence of postoperative apnea following inguinal herniorrhaphy under general anesthesia in infants younger than 60 weeks PCA was 20.7%, which is considerable. We recommend longer surveillance and monitoring in recovery room for these infants with high-risk of postoperative apnea. This should be followed by evaluation of risk factors to determine the indication for elective intensive care unit transfer for longer-term monitoring of higher-risk patients.

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Introduction

Inguinal hernia is a common neonatal disease, particularly in premature and low-birth-weight infants. Multiple studies have reported postoperative apnea with routine doses of anesthetics and its association with gestational age less than 37 weeks or post conceptional age (PCA) under 60 weeks at the time of operation[1-3]. In preterm infants undergoing herniorrhaphy, episodes of apnea and bradycardia are likely during the postoperative period[3]. Apnea in premature infants is associated with many complications such as bradycardia, cyanosis, brain damage, hypotension, hypotonia, hydrocephalus, neurologic complications, and even death[4]. The main cause of apnea and respiratory problems in premature infants is an incomplete development of respiratory centers[5]. Other factors, such as early fatigability of the diaphragm, airway

*** Corresponding Author;**
Address: Cardiac Anesthesia Research Center, Imam-Reza hospital, School of medicine, Mashhad University of Medical Science, Mashhad, IRAN
E-mail: razavim@mums.ac.ir

obstruction, hypothermia, side effects of muscle relaxants, infections, sepsis, metabolic and cardiac diseases, and anemia have also been shown to be associated with apnea in these infants[5-7].

In this study, we have examined factors associated with apnea in infants younger than 60 weeks PCA at the time of herniorrhaphy. Knowledge of these risk factors can help us estimate the risk of apnea in these infants and identify the need for postoperative supportive measures and intensive care in special cases. However, a detailed study has not been done in this field in our country.

Subjects and Methods

This is a cross-sectional study of infants with less than 40 weeks gestation at birth and less than 60 weeks post-conceptional age at the time of operation. After obtaining approval of the local ethics committee and informed parental consent, we studied 150 infants presenting for elective inguinal herniorrhaphy in Dr. Sheikh Children's Hospital Medical Center, Mashhad, Iran over eight months in 2012. Sample size was estimated by using the formula: $n = \frac{p(1-p)z2}{d2}$.

p=proportion of patients who had apnea (according to Kurth CD study[8], the ratio of approximately 25% is estimated), d=accepted variation 0.07, z=1.96 and n=147. Exclusion criteria included intraoperative hemodynamic changes greater than 20% from the basal rates, incidental need for extra surgery during the operation, and hypothermia due to environmental conditions. Apnea was defined as respiratory pause of >6 seconds and less than 15 seconds (short apnea). Infant-related information including gestational age (according to questioning parents and the medical records), postconceptional age (gestational age + age after birth), gender, weight at birth and before operation, history of oxygen therapy, prior apnea, mechanical ventilation, concurrent abnormalities, and apnea-related cyanosis and bradycardia was gathered using a questionnaire. Bradycardia was defined as a heart rate measured by electrocardiogram (ECG) and confirmed by pulse oximetry pulse rate of less than 100/min for any duration. Hemoglobin oxygen desaturation was defined as a decrease of Spo_2, to less than 90% for 10s or more. Following sampling, patients were divided into three groups: those without apnea, those with apnea in the recovery room, and those with apnea in the ward.

For all patients, anesthesia was induced by 6-8% sevoflurane and maintained by 0.5 µg/kg/min remifentanil, 0.3-0.6 mg/kg atracurium, and 60% N_2O. Intraoperative temperature was monitored using an oropharyngeal thermometer. All patients were extubated upon full awakening and monitored for two hours in the recovery room and 10 hours in the ward using pulse oximetry and nasal capnograph (Capnocheck®Sleep Capnograph/Oximeter).

Demographic data were analyzed by using descriptive statistics. Continuous variables were compared between groups by using the Mann Whitney U test for non parametric data and Student's t-test for parametric data. Independent risk factors were analyzed by using Chi square test. Results related to quantitative variables are shown as mean ± standard deviation.

Data analysis was performed by SPSS statistical software (version 13). $P<0.05$ was considered statistically significant.

Findings

One-hundred and sixteen (77.3%) of the subjects were born at term and 34 (22.7%) preterm. Anemia (Hb<10 g/dL) existed in 92 (61.3%) the children. Demographic data such as GA, PCA, weight at birth and at operation, and Hb are summarized in Table 1.

Gestational age, postconceptional age, birth weight, and hemoglobin level were compared. Apnea was significant and dependant to gestational age (P=0.001), PCA (P=0.002), birth weight (P=0.003) and weight before operation (P=0.012), but there was no relation between hemoglobin and postoperative apnea. Totally, 119 (79.3%) patients did not have postoperative apnea, while 31 (20.7%) did, of whom 27 (18%) had apnea in the recovery room and 4 (2.6%) developed it on the ward.

Table 1: Comparison of age, sex, weight at birth and at operation, and hemoglobin in the three groups studied

Variable		without apnea	apnea in the recovery room	apnea on the ward	*P.* value*
Gestational age (weeks)		37.5 (2.11)	35.64 (2.73)	36.02 (2.0)	0.001
Sex	**boy**	100 (84.0)	23 (85.2)	2 (50.0)	0.2
	girl	19 (16.0)	4 (14.8)	2 (50.0)	
Birth weight (kg)		2.92 (0.68)	2.32 (0.81)	2.08 (1.01)	0.003
Weight at operation (kg)		4.94 (1.49)	3.89 (0.95)	3.66 (1.15)	0.01
Hemoglobin		10.17 (1.68)	9.81 (2.01)	7.93 (0.75)	0.09

There were no statistically significant differences between the apnea and without apnea groups with respect to the mean anesthesia times (63±14.3 min vs 59±17.4 min respectively, *P*=0.5). History of mechanical ventilation, oxygen therapy, and apnea in the three groups is demonstrated in Table 2. Significant association was observed between postoperative apnea with history of oxygen therapy (*P*=0.03), prior apnea (*P*=0.001) and no significant difference with previous mechanical ventilation (*P*=0.2).

We also evaluated bradycardia (HR<100/min) and cyanosis (SPO_2<90% and blue lips). From the 31 apneic patients, 5 (16.1%) and 2 (6.4%) patients had bradycardia in recovery room and in the ward, respectively (*P*=0.001). Also cyanosis was observed in 15 (48.3%) patients in recovery room and 2 patients (6.4%) in the ward (*P*=0.001).

With regard to comorbidities (Table 3), multiple birth was associated with apnea in the recovery room (*P*=0.001), while metabolic and cardiac abnormalities were significantly associated with delayed apnea in the ward (*P*=0.002).

Discussion

In our study of 150 children younger than 60 weeks PCA undergoing herniorrhaphy under general anesthesia, we observed a total of 31 cases of apnea (20.7%).

Malviya et al (1993) have reported the incidence of apnea to be 26.3% in infants younger than 60 weeks PCA undergoing herniorrhaphy under general anesthesia[9]. In another study of premature infants undergoing herniorrhaphy, the incidence of postoperative apnea has been reported at 23%[10], which is close to what we have reported.

Welborn et al have identified anemia as an independent risk factor for postoperative apnea[11]. According to their study, apnea and bradycardia were observed in 21% of patients with normal hematocrit, as compared to 80% in patients with severe anemia. Although the incidence of apnea in our study population was similarly 20.7%, we did not find any significant association between hemoglobin levels below 10 g/dL and apnea.

In a five-year study of 126 premature infants who had undergone general anesthesia for inguinal herniorrhaphy, five (4.7%) patients developed postoperative apnea[12]. According to this study, postoperative apnea in premature infants after inguinal hernia repair using current anesthetic techniques is much less common than previously reported (4.7% vs 49%), and patients with a prior history of apnea were at the highest

Table 2: History of oxygen therapy, apnea, and mechanical ventilation and postoperative apnea

Previous records		Without apnea n (%)	Apnea in recovery room n (%)	Apnea in the ward n (%)	*P.* value
Oxygen therapy	No	98 (82.4)	17 (63.0)	2 (50.0)	0.03
	Yes	21 (17.6)	10 (37.0)	2 (50.0)	
Apnea	No	119 (100)	23 (85.2)	3 (75.0)	0.001
	Yes	0	4 (14.8)	1 (25.5)	
Mechanical Ventilation	No	117 (98.3)	25 (92.6)	4 (100)	0.2
	Yes	2 (1.7)	2 (7.4)	0	

Table 3: Distribution between existence of comorbidities and postoperative apnea

Medical history	without apnea n=119 (%)	Apnea in the recovery room n=27 (%)	Apnea in the ward n=4 (%)	*P.* value
Negative	96 (80.7)	25 (92.6)	1 (25.0)	0.7
Skeletal abnormalities	6 (5.0)	0	0	0.8
Metabolic anomalies and icterus	7 (5.9)	0	2 (50.0)	0.002
Cardiac abnormalities	5 (4.2)	0	1 (25.0)	0.3
Multiple birth	5 (4.2)	2 (7.4)	0	0.001

risk for apnea; other risk factors included gestational age, birth weight, weight at the time of surgery, and complicating neonatal diseases. The authors have recommended ICU monitoring only for high-risk patients. Apnea risk factors identified in this study are similar to our findings.

In a retrospective study of 191 infants undergoing inguinal herniorrhaphy, most episodes of apnea were found to occur during the first four hours after the surgery and the risk of postoperative apnea/bradycardia was reported 8.8%[13]. The authors recommend not using narcotics and vecuronium. Besides, since most incidents of apnea occur early (i.e. within four hours after surgery), it has been recommended that inguinal herniorrhaphy be performed on an outpatient basis, which is more cost-efficient[14,15]. Considering the time needed for postoperative monitoring, another study has recommended that children younger than 46 weeks PCA should be monitored for at least 12 hours after surgery[16]. Children with postconceptional age of 46-60 weeks should be monitored for 12 hours only if they have a history of apnea, chronic pulmonary disease, neurological disease, or anemia. Silins et al demonstrated that predictive factors for postanesthetic care unit (PACU) after herniorraphy in infants <6 months were related to anesthesia techniques and perinatal outcomes[5].

In our study, the incidence of delayed apnea in the ward within 10 hours after surgery was 2.6% and it was significantly associated with risk factors including gestational age, birth weight, weight at the time of operation, history of oxygen therapy, history of apnea, and metabolic and cardiac abnormalities.

In another study of eleven risk factors associated with neonatal apnea, apnea was strongly associated with gestational age and age since conception, particularly if <47 weeks[17]. Prior apnea and anemia were important risk factors, especially in patients with PCA <43 weeks. Other risk factors studied including birth weight, weight at operation, respiratory distress syndrome, bronchopulmonary dysplasia, necrotizing enterocolitis, and use of narcotics or muscle relaxants were not associated with development of apnea. In our study, however, birth weight and history of pulmonary disease were significantly associated with apnea.

The overall risk of apnea/bradycardia in our study population was 4.7%, including 3.3% in the recovery room and 1.3% on the ward. Besides, the overall risk of apnea/cyanosis was 11.3%, including 10% in the recovery room and 1.3% on the ward. Considering the risk of these potentially dangerous complications and in particular, their association with the identified risk factors, our findings indicate the need for a minimum of 10 hours of postoperative respiratory monitoring following general anesthesia.

Conclusion

Risk factors associated with postoperative apnea included gestational age, birth weight, history of apnea or oxygen therapy, icterus, and metabolic or cardiac diseases. We therefore recommend longer surveillance and monitoring of such patients in the recovery room, then evaluation of risk factors for intensive care unit (ICU) transfer and longer-term monitoring in higher-risk infants.

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Authors' Contribution

M. Gharavi-Fard: Concept/ Design, Drafting of the manuscript
M. Taghavi-Gilani: Data analysis/ Interpretation
S. kazemi: Acquisition of data and Drafting of the manuscript
M. Razavi: Acquisition of data and Critical revision of the manuscript
All authors approved final version of the paper.

Conflict of Interest: None

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