GAVIN PUBLISHERS

Archives of Pediatrics

Nam SH and Kwon KA. Arch Pediatr 2: JPED-132.

Research Article

DOI: 10.29011/2575-825X.100032

When We Have to Do Inguinal Hernia Repair for Preterm Babies? -Incidence of Surgical Complications and Analysis of Postoperative Apnea Risk Factors

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Citation: Nam SH, Kwon KA (2017) When We Have to Do Inguinal Hernia Repair for Preterm Babies? -Incidence of Surgical Complications and Analysis of Postoperative Apnea Risk Factors. Arch Pediatr 2: 132. DOI: 10.29011/2575-825X.100032

Received Date: 18 October, 2017; **Accepted Date:** 06 November, 2017; **Published Date:** 13 November, 2017

Abstract

Objective: We want to know the complication rates after inguinal herniorrhaphy and the risk factors of postoperative apnea for infants younger than correctional age of 60 weeks.

Design: Retrospective, descriptive study.

Subjects: 114 of premature babies (M: F=77:37) who underwent inguinal herniorrhaphy within correctional age of 60 weeks were reviewed between January 2010 and February 2017.

Methods: The medical records for gender, gestational age, birth weight, correction age at the time of repair, body weight at the time of repair, hemoglobin level at the time of repair, concurrent comorbidities, and the duration of the operation / anesthesia were retrospectively reviewed.

Results: Gestational age was mean 31.1 weeks and birth weight was mean 1,533.4 g. The time of repair was mean correctional age 27.6 days at the body weight of 3,979.2 g. Postoperative apnea was discovered in 15.8% (n=18) and overall complication rate was 2.68%. In a univariate analysis, we found the significant risk factors as young gestational age, low birth weight, repair during NICU admission and low body weight at repair. In a multivariate analysis, small body weight at the repair time was the only significant factors. According to ROC curves, the 3,250 g of body weight at the repair was the cut-off points for the prediction of postoperative apnea episodes.

Conclusion: The postoperative apnea rate was 15.8% and the surgical complication rate was 2.68%. To decide the operation timing for preterm babies, a body weight of 3,250g would be the reference value.

Keywords: Inguinal Hernia; Prematurity; Postoperative Apnea

Introduction

Inguinal hernia in children is caused by the incomplete obliteration of the processes vaginalis. Although this can become evident at any age, it is more frequent in premature infants [1]. The prevalence of inguinal hernia in premature infants has been shown to be anywhere from 5% to 30% [2]. Though surgical correction of inguinal hernia is one of the most common procedures for pediatric surgeons, it remains still very difficult to decide the proper timing for the procedure in premature babies [3]. When faced with timing the hernia repair for premature babies, there are two camps of thought. Some authors recommend early repair to decrease the risk of incarceration and prevent testicular atrophy [4-15]. The other camp recommends delaying the surgery due to the difficulty of general anesthesia and the possibility of postoperative apnea [4,5]. It has been demonstrated that a post-conceptional age of < 60 weeks and particularly below 45 weeks is strong predictor for postoperative apnea [6]. In our experience, the hernia sac of

premature babies is wider than in infants. We often faced the patients who had a huge hernia sac occupying most of the inguinal area while waiting to schedule the surgery. It was associated with thin vas deferens and testicular vessel. Also, it is very difficult to handle the hernia sac and separate from the vas deferens. For these reasons, we prefer early repair than delaying the repair over correctional age of 60 weeks despite the possibility of postoperative apnea. Herein, we retrospectively studied the complication rates after inguinal herniorrhaphy and the actual incidences of postoperative apnea for premature babies who underwent the repair within correctional age of 60 weeks. We investigated the risk factors for postoperative apnea in premature babies and we want to predict the apnea and figure out how to manage.

Materials and Methods

Inclusion Criteria & Approval of Ethical Committee

A total of 114 premature babies (77 males & 37 females) who underwent surgical treatment between March 2010 and February 2017 at Haeundae Paik Hospital and Dong-A Medical Center for inguinal hernia within correctional age of 60 weeks were included in this study. Single surgeon did 220 inguinal hernia repairs for infants younger than correctional age of 60 weeks. Among them, we excluded 98 of full term babies and 8 premature babies on ventilator for severe bronchopulmonary dysplasia (BPD) and cor pulmonale. The study protocol was approved by Dong-A Medical Center (DAUHIRB-17-078) and Haeundae Paik Hospital (HPIRB 2017-04-011-002).

General Anesthesia and Operation

Premature babies were categorized as patients born less than 37 weeks of gestational age. We schedule the inguinal herniorrhaphy just prior to discharging of the patient if (s)he was leaving the Neonatal Intensive Care Unit (NICU) at a weight over 2 kg. If the hernia was recognized after leaving NICU, the repair time for inguinal hernia was considered according to baby's general condition. All of herniorrhaphy procedures via inguinal incisions were conducted by a single surgeon under general anesthesia. General anesthesia was induced and maintained with sevoflurane in air/oxygen, and neuromuscular blocking agents were administrated for endotracheal intubation. No opioids or nitrous oxide were allowed intraoperatively.

Postoperative Management and Definition of Postoperative Apnea

All of babies were hospitalized for at least 24 hours with oxygen saturation monitoring after operation. For the patients who were admitted in NICU, we remove the endotracheal tube in the NICU after coming back from operating room. If the patient was dependent on ventilator for longer than 4 hours without self-respiration, we assessed that postoperative apnea occurred. For patients who got an extubation in the operating room, postoperative apnea was defined as a SpO2 < 90% for 10 s without respiratory movements [6]. We retrospectively reviewed the medical records for gender, gestational age, birth weight, correction age at the time of repair, body weight at the time of repair, hemoglobin level at the time of repair, concurrent comorbidities, and the duration of the operation / anesthesia.

Data Analysis and Statistics

Postoperative complications including apnea, wound infection, intraoperative vas injury, recurrence, and testicular atrophy within one year of the surgeries were investigated. We analyzed categorical variables using the chi-square test and Fischer's exact test using the SPSS statistical software (Version 20 for Windows; SPSS Inc., Chicago, IL). Univariate and multivariate analyses for the evaluation of the risk factors were assessed by logistic regression. The cut-off levels of risk factors were determined by the level to maximize (Sensitivity + Specificity) for predicting the postoperative apnea in the Receiver Operating Characteristic (ROC) curves. P-values were two-tailed and <0.05 was considered significant.

Results

Demographic findings (Table 1)

One hundred and fourteen premature babies (77 males, 37 females) underwent the operation for inguinal hernia. Mean gestational age was 31.1 ± 3.8 weeks and birth weight were 1,533.4 ± 701.3 g. Sixty-two patients (54.3%) were very low birth weight infants. The time of repair was mean correctional age 27.6 ± 32.2 days at the body weight of 3,979.2 ± 1,460.7 g. 21 of premature infants (18.4%) underwent the surgery just before discharge from NICU and 93 babies readmitted for surgery. 14 of patients had bronchopulmonary dysplasia. Preoperative incarceration episode was observed in 22 patients (19.3%). Except one case of strangulation, it was successful for reduction. Mean operation time was 38.5 ± 27.8 min and anesthesia time was 64.7 ± 28.9 min. Preoperative hemoglobin level was 10.6 ± 1.4 g/dL. 86 infants underwent bilateral inguinal hernia repair, and right side inguinal hernia repair was performed for 18 infants. Ten infants underwent left side only.

Variables	Total	Apnea (-)	Apnea (+)
	n=114	n=96	n=18
Gender (Male : Female)	77:37:00	64:32:00	13:05
Gestational age (weeks), mean (SD)	31.1 ± 3.82	31.7 ± 3.8	28.0 ± 2.2
Birth weight (g), mean (SD)	1,533.4 ± 701.3	1,618.9 ± 726.5	1,077.2 ± 239.9
Correctional age at hernia repair (days), mean (SD)	27.6 ± 32.2	31.4 ± 31.8	7.1 ± 26.3
Body weight at hernia repair (g), mean (SD)	3,979.2 ± 1,460.7	4,201.2 ± 1,458.3	2,795.6 ± 733.2

Repair during NICU* admission	21 (18.4%)	12 (12.5%)	9 (50%)
History of incarceration	22 (19.3%)	17 (17.7%)	5 (27.7%)
Underlying BPD#	14 (12.3%)	12 (12.5%)	2 (11.1%)
Operation time (min), mean (SD)	38.5 ± 27.8	38.6 ± 29.6	38.2 ± 14.5
Anesthesia time (min), mean (SD)	64.7 ± 28.9	66.3 ± 30.4	61.3 ± 17.4
Hemoglobin (g/dL), mean (SD)	10.6 ± 1.4	10.7± 1.4	10.1 ± 1.2

Table 1: The occurrence of postoperative apnea according to risk factors.

All values are number (%).

*: neonatal intensive care unit

#: bronchopulmonary dysplasia

Postoperative Complications

Postoperative apnea was discovered in 15.8% (n=18) of patients without postoperative apnea-related complications. Overall complication rate was 2.68%, including postoperative hydrocele (n=3, 2.6%), and testicular atrophy (n=1, 0.08%). There was neither recurrence nor wound complications. Metachronous contralateral hernia was found in 3 cases (2.6 %).

Risk Factors of Postoperative Apnea in Premature Baby

Postoperative apnea occurred for the patients with younger gestational age (31.7 ± 3.8 weeks vs. 28 ± 2.2 weeks, P <0.001) with lower birth weight (1,618 ± 726.5 g vs. 1,077 ± 239.9 g, P=004). It was more frequent for the patients who underwent the operation before discharge from NICU (P =0.001). Correctional age at repair was younger in apnea occurrence group (31.4 ± 31.8 days vs. 7.1 ± 26.3 days, P =0.002), and the body weight at the repair time was also influential for occurrence of apnea (4,201.2 ± 1,458.3 vs. 2,795.6 ± 733.2, P <0.001). The hemoglobin levels, underlying BPD and the duration of the operation/anesthesia didn't show significant difference between two groups (Table 1). In logistic regression analysis, we found the significant risk factors as gestational age, birth weight, hernia repair during NICU admission, correctional age at repair, and body weight at repair. In a multivariate analysis, small body weight at the repair time was the only significant factors for postoperative apnea episodes (P =0.006) (Table 2). Using this result, we calculated the cut-off value for the occurrence of apnea using ROC (Receiver Operation Characteristic) curves. The 3,250 g of body weight at the repair time (72.9% sensitivity & 83.3% specificity) was the cut-off points for the prediction of postoperative apnea episodes (Figure 1). The infant less than 3,250g of body weight at the operation was vulnerable for postoperative apnea. (area under the curve = .819)

	Univariate		**Multi-variate**	
Variables	**Odds (95% CI)**	**P -value**	**Odds (95% CI)**	**P -value**
Gender	1.300(0.426-3.97)	0.645		
Gestational age	0.961(0.940-0.983)	<0.001	0.975(0.950-1.001)	0.057
Birth weight	0.998(0.997-1.000)	0.004		
Repair during NICU* admission	7.000(2.320-21.12)	0.001		
Underlying BPD#	1.143(0.233-5.602)	0.869		
History of incarceration	0.559(0.176-1.779)	0.325		
Correctional age at repair	0.959(0.933-0.985)	0.002		
Body weight at operation	0.999(0.998-0.999)	<0.001	0.999(0.998-1.000)	0.006
Hemoglobin	0.938(0.657-1.339)	0.725		
Operation time	0.999(0.981-1.018)	0.954		
Anesthesia time	0.983(0.959-1.008)	0.179		

*: Neonatal Intensive Care Unit
#: Bronchopulmonary Dysplasia

Table 2: Univariate and multivariate analysis of postoperative apnea episode.

All values are number (%).

*: neonatal intensive care unit

#: bronchopulmonary dysplasia

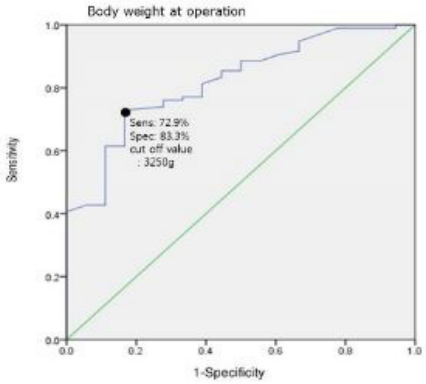

Figure 1: The cut-off points of body weight at operation for the prediction of postoperative apnea episodes.

Discussion

Inguinal hernias are common in premature infants, with an incidence rate of 13% in infants born less than 32 weeks of gestational age and up to 30% in infants born weighing less than 1 kg [7]. Though high prevalence of inguinal hernia, still we don't have clear guideline for inguinal hernia repair under general anesthesia because preterm baby younger than correctional age of 60 weeks is susceptible for postoperative apnea. Even though a few of operations are possible under regional anesthesia, it is not always available in all institutions. Also, it has risks of multiple and/or failed attempts and conversion to general anesthesia [16]. It makes an ongoing debate on when to schedule the inguinal hernia repair for premature baby.

Many pediatric surgeons believe that hernias discovered during admission to the neonatal intensive care unit should be corrected before discharge from the NICU [14]. Fortunately, delaying the inguinal hernia repair for premature baby in admitted at NICU did not increase the risk of incarceration (the overall risk was as low as 4.6%), thus allowing premature infants to be repaired closer to term [8,14]. We found that the history of incarceration was around 20%. It was not associated with postoperative apnea episode, but it could be considerable reason for early repair within correctional age of 60 weeks.

Besides the risks of apnea, we have to consider the technical difficulties and surgical complications. In general, the hernia sac is large, very thin, and fragile in premature babies. It is very difficult and troublesome to handle in the small anatomic spaces. Because incomplete ligation of the hernia sac can also cause recurrence and postoperative hydrocele, complete ligation of entire circle of hernia sac is essential. Also enlarged hernia sac can pose a risk of injury of the testicular vessel and vas deferens. One case of testicular atrophy was associated with strangulated hernia and the large hernia sac. Due to these additional surgical complications from enlarged hernia sac, we prefer to early repair despite the risk of postoperative apnea. We believe this strategy can result in a good surgical outcome as evidenced by the low surgical complication rate of 2.68% without recurrence.

Apnea in premature babies can be complicated by and result in bradycardia, cyanosis, hypotension, hypotonia, hydrocephalus, neurologic complications, and even death [1]. Traditionally, apnea is strongly and inversely related to gestational age and Postconceptional Age (PCA). Ozdemir and Arikan concluded that infants younger than 45 weeks PCA were more likely to develop postoperative apnea [5]. Cote et al, reported that anemia was a significant risk factor for apnea, particularly for patients >43 weeks PCA [17]. Qazi Iqbal et al. suggested a weight <2500g and gestational age <34 weeks as predictors for risk factors and poor outcomes of ventilated neonates [11].

In our study, apnea occurrence rate after inguinal hernia repairs within correctional age of 60 weeks was 15.8%. The incidence of apnea in the premature babies may be overestimated due to the non-aggressive extubation by the anesthesiologist and neonatologist for premature patients admitted to the NICU. In agreement with the results in other studies, short gestational age (days) and small body weight were highly correlated to postoperative apnea episodes. We found that the rate of apnea was significantly higher when they underwent the operation before NICU discharge. It is no wonder they were much smaller than readmitted preterm infants. The gestational age and birth weight can't be controlled, but the correctional age of repair and body weight were modifiable factors for surgeons. Although the corrective age at the time of surgery was not statistically significant, it should be closely related to weight at the time of surgery. The body weight at the time of repair was a strong predictive factor for postoperative apnea in this study. We found the reference values originated our results, and it was 3,250g of body weight. It might be an indicator to decide operation timing for preterm baby who needs hernia repair after discharge from NICU.

In contrast, some anesthesiologists recommend delaying the hernia repair due to the neurodegenerative effects of anesthetics in neonates. In one experiment, rats receiving tissue injuries under anesthesia displayed lower recollection scores related to object recognition memory [12]. These authors also assessed Child Behavior Checklist scores of children and suggested that anesthetized children displayed a corresponding lower recollection score [12]. These reports and studies point to waiting as long as possible to schedule an inguinal hernia repair. But there has not been proven about a cause and effect relationship between early exposure of anesthesia and neurocognitive development [16]. Until further researches provide new evidence, we need to decide the surgery weighing the risks of delaying the surgery versus the urgency of surgery. There are several limitations of this study, the foremost being that this is a retrospective study. Most of the premature babies underwent a bilateral inguinal herniorrhaphy. This could have

skewed the incidence of metachronous hernia. We also could not compare these procedures with laparoscopic surgeries to identify the differences in rates of complications. We believe a laparoscopic approach for small infants needs longer operation times with less technical feasibilities. Despite these limitations, we found that early inguinal herniorrhaphy for ex-preterm infants less than correctional age 60 weeks was feasible and overall complication rates were within acceptable ranges. There were neither complications from apnea nor general anesthesia. Further studies about neurodevelopmental status would be needed for long term follow up. We suggest that it is better to do surgery before discharge from NICU because of high incidence of apnea. For the ex-preterm baby after discharge from NICU, the early repair within PCA 60 weeks should be done with a heavy reference to body weight and correctional age.

Conclusion

Hernia repair for preterm baby under general anesthesia increases the apnea episode. Early hernia repair within correctional age 60 weeks accompanies 15.8% of postoperative apnea with low complication rate (2.68%). To decide the operation timing for preterm babies, a body weight of 3,250g would be the reference value.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Acknowledgement

This work was supported by the Dong-A University research fund. We really appreciate to Kwang Min Lee for statistical analysis and Ji Won Jang for data collection.

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