Original Article

Vajira Med J
Journal of Urban Medicine

The Incidence and Factors Related to the Retinopathy of Prematurity in a Tertiary Hospital in Bangkok, Thailand

Chavisa Bunyavee MD[1], **Kornwipa Hemarat** MD[1]

[1] *Department of Ophthalmology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok 10300, Thailand*

ABSTRACT

OBJECTIVE: To address the incidence, treatment outcomes, and risk factors of retinopathy of prematurity (ROP).

METHODS: The medical records were retrospectively reviewed of preterm infants who were examined for ROP at Vajira Hospital during 2015-2020. All demographic data, prenatal, postnatal conditions, ophthalmic findings, and treatment were collected.

RESULTS: Of 142 screened infants, 54 infants (38%) had ROP and 28 of them had sight-threatening ROP (24 infants with prethreshold type 1; 4 infants with prethreshold type 2). All ROP infants were born with a gestational age of fewer than 30 weeks or birthweight less than 1500 g. In multivariate analysis, low gestational age (≤ 30 weeks) and hypoglycemia were associated with any stage of ROP development. While duration of endotracheal intubation of more than 30 days and inguinal hernia were independently associated with severe ROP. Most ROP infants were finally regressed. Only 4 infants were referred out for vitreoretinal surgery.

CONCLUSION: The overall ROP incidence was 38%. Even though a majority of ROP patients recovered, recognizing possible factors helped in ROP detection and progression awareness.

KEYWORDS: incidence, outcomes, retinopathy of prematurity, risk factor

INTRODUCTION

Retinopathy of prematurity (ROP) is a major cause of childhood visual impairment and blindness in Thailand[1]. The prevention of ocular complications from ROP is early detection and treatment. Faculty of Medicine, Vajira Hospital, has adopted the American Academy of Ophthalmology (AAO) screening policy[2] into a current screening guideline which includes infants born with gestational age (GA) at birth ≤ 30 weeks or birth weight (BW) ≤ 1500 g or birth weight between 1500-2000 g with unstable clinical courses.

As the Vajira hospital is a tertiary referral center as well as a medical school, many preterm infants were born with very low GA and BW. Therefore, a screening protocol should be customized upon our hospital conditions because the patient's conditions may differ from the standard guideline that was developed in North America.

This study aims to report on our current ROP database, including the incidence and outcomes of ROP treatment, as well as the factors affecting ROP development, in order to improve the quality of ROP screening and care of preterm infants.

Corresponding Author: Kornwipa Hemarat
Email: kornwipa@nmu.ac.th
Received: 10 April 2023
Revised: 6 September 2023
Accepted: 8 September 2023
http://dx.doi.org/10.14456/vmj.2023.21

METHODS

This study was conducted at Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand, and approved by Vajira Institutional Review Board (COA 132/2563). Data were obtained retrospectively through an electronic medical chart review from January 1st, 2015 to December 31st,2020. All infants screened for ROP were reviewed. Our screening policy included all preterm infants born with GA ≤ 30 weeks or BW ≤ 1500 g. Other preterm infants whose GA or BW was above the requirement may be included in the screening due to poor medical conditions under a neonatologist's request. The inclusion criteria were preterm infants who had completed the ROP screening exam and followed up until retinal vascularization reached zone 3 or ROP was regressed. Exclusion criteria were infants with incomplete medical records and infants who lost follow-up exams before the postmenstrual age of 35 weeks. Before 2017, most screening examinations were performed by a retina specialist (Tanyakittikul P). After 2017, either a pediatric ophthalmologist (Bunyavee Ch) or a retina specialist (Hemarat K) examined by using indirect ophthalmoscopy with scleral depressions. ROP staging, zoning, and plus assessment were based on the International Classification of Retinopathy of Prematurity[3] and the Early Treatment of Retinopathy of Prematurity study[4]. In addition to prethreshold type 1 with plus disease, any stage zone 1 ROP with preplus disease and stage 2,3 zone 2 ROP with preplus disease were included in prethreshold type 1 ROP. Severe ROP was defined as ROP requiring treatment which was either laser photocoagulation or intravitreal bevacizumab or combined. Laser photocoagulation was performed under general anesthesia or at the bedside and intravitreal bevacizumab injection was performed in some type 1 ROP, particularly in zone 1 disease or infants who cannot tolerate a laser procedure. The follow-up visit timing complied with the AAO ROP screening policy[2].

Patient demographic data, prenatal, perinatal, and postnatal history during the infant's admission were collected. All clinical diagnoses were retrieved from the pediatrician's records. The ophthalmic findings were collected from ROP record forms. The primary outcome was the incidence of ROP. Secondary outcomes were final ROP findings and associated factor with ROP development.

The preterm infants' baseline continuous data including GA, BW, and maternal age were described as means ± standard deviation or median with interquartile range depending on the normality of distribution. Continuous data were analyzed by sample T-test or Mann–Whitney U test. Categorical data were analyzed by Chi-squared test or Fisher's exact test. GA and BW were categorized according to AAO guideline and compared across 3 groups of the final ROP findings (no ROP, spontaneous regressed ROP, and ROP requiring treatment). For the possible risk factors for the ROP development including GA, BW, duration of oxygen treatment, duration of endotracheal intubation, maternal and infants' comorbidities such as gestational diabetes mellitus, preeclampsia, eclampsia, premature rupture of membrane, chorioamnionitis, patent ductus arteriosus, pulmonary complications (apnea of prematurity, bronchopulmonary dysplasia, respiratory distress syndrome, pneumothorax, persistent pulmonary hypertension of the newborn and pulmonary hemorrhage), intraventricular hemorrhage, brain complications (hypoxic ischemic encephalopathy, intraventricular hemorrhage, periventricular leukomalacia, neonatal seizure, epilepsy, cerebral atrophy), necrotizing enterocolitis, anemia, thrombocytopenia, hyperglycemia, hypoglycemia, pneumonia, urinary tract infection, meningitis, sepsis, inguinal hernia, osteopenia, history of general anesthesia and beta-blocker usage were analyzed with univariate analysis. The factors with p-value < 0.05 were selected for multivariable analysis. The binary logistic regression was used to calculate p-value and odd ratio. Statistical analysis was performed by using IBM SPSS statistics version 23.

RESULTS

There were 162 preterm infants screened for ROP during 2015-2020 at Vajira Hospital. Only 142 cases were included in this study. Seventeen patients were excluded due to lost follow-up, and three were excluded due to incomplete medical records.

The mean GA at birth was 29.9 ± 2.8 weeks. The mean birth weight was 1196.0 ± 395.9 g. The mean postmenstrual age at the first exam was 34.2 ± 2.5 weeks. Baseline patients demographic data were shown in Table 1. The median GA at birth and the mean birth weight in infants with ROP were statistically significantly lower than the infants who had no ROP ($p < 0.001$).

Most infants (120 of 142 [85%]) were screened due to GA less than 30 weeks and/or BW less than 1500 g. Other 22 infants (15%) whose GA and BW were above the screening criteria but were screened owing to unstable clinical courses such as having noninvasive/invasive oxygen ventilation, sepsis, necrotizing enterocolitis, and post-arrest.

ROP was found in 54 infants (38%). Prethreshold ROP was 19.7% (24 infants with prethreshold type 1; 4 infants with prethreshold type 2). All prethreshold ROP infants were born with GA ≤ 30 weeks or BW less than 1500 g. Only 2 infants who were born above the screening criteria had ROP but required no treatment. The mean GA at the birth of non-ROP infants was 31.0 ± 2.3 weeks, and for severe ROP infants were 26.9 ± 1.9 weeks. The mean BW of non-ROP infants was 1341.7 ± 371.7 g, and that severe ROP infants were 826.3 ± 201.2 g. The severity of ROP classified to GA and BW was shown in Table 2.

Table 1 Baseline characteristics of 142 neonates screened for ROP

	No ROP	Any ROP	P-value
Median gestational age at birth (weeks) (median, IQR)	31 (29,33)	28 (27,30)	< 0.001[a]
Mean birth weight (grams) (mean, SD)	1341.7 ± 371.7	958.6 ± 312.4	< 0.001[b]
Mean maternal age (years) (mean, SD)	29.3 ± 7.1	29.9 ± 7.0	0.64[b]
Route of delivery (n, %)			0.619[c]
Vaginal delivery	29 (33.0%)	20 (37.0%)	
Cesarean delivery	59 (67.0%)	34 (63.0%)	
Multiple births (n, %)			0.158[c]
Singleton	71 (80.7%)	38 (70.4%)	
Multiple (twin, triplet)	17 (19.3%)	16 (29.6%)	
Maternal complications (n, %)			
GDM/DM			0.373[d]
Yes	6 (6.8%)	6 (11.1%)	
No	82 (93.2%)	48 (88.9%)	
Pre/eclampsia			0.025[c]
Yes	26 (29.5%)	7 (13.0%)	
No	62 (70.5%)	47 (87.0%)	
PROM			0.526[c]
Yes	22 (25.0%)	11 (20.4%)	
No	66 (75.0%)	43 (79.6%)	
Chorioamnionitis			0.635[d]
Yes	2 (2.3%)	2 (3.7%)	
No	86 (97.7%)	52 (96.3%)	

Abbreviations: DM, diabetes mellitus; GDM, gestational diabetes mellitus; IQR, interquartile range; n, number; PROM, premature rupture of membranes; ROP, retinopathy of prematurity; SD, standard deviation
[a] p-value by Mann–Whitney U Test
[b] p-value by Independent T-Test
[c] p-value by Chi-Square
[d] p-value by Fisher's Exact Test

Table 2 Severity of ROP according to gestational age and birthweight

	No ROP	Spontaneously regressed ROP	Severe ROP requiring treatment	P-value
Gestational age				< 0.001[a]
≤ 30 weeks	38 (43.2%)	21 (75%)	25 (96.2%)	
> 30 weeks	50 (56.8%)	7 (25%)	1 (3.8%)*	
Birthweight				0.010[b]
≤ 1500 g	65 (73.9%)	25(89.3%)	26 (100%)	
1500-2000 g	20 (22.7%)	2 (7.1%)	0 (0%)	
> 2000 g	3 (3.4%)	1 (3.6%)	0 (0%)	
Gestational age and birthweight				0.005[b]
GA > 30 weeks and BW > 1500 g	20 (22.7%)	2 (7.1%)	0 (0%)	
Others	68 (77.3%)	26 (92.9%)	26 (100%)	

Abbreviations: BW, birthweight; g, gram; GA, gestational age; ROP, retinopathy of prematurity
[a] p-value by Chi-Square
[b] p-value by Fisher's Exact Test
*Note: This infant was born at GA 31 weeks and had BW of 1160 g.

The mean postmenstrual age at the first abnormal detected ROP was 35.7 ± 2.9 weeks (ranging, 32-44 weeks). The mean postmenstrual age at the first intervention was 37.2 ± 2.3 weeks (ranging, 33-45 weeks)

All type 1 prethreshold ROP infants were treated by laser photocoagulation and/or intravitreal bevacizumab. Intravitreal bevacizumab injection was done in 5 infants with prethreshold type 1 zone 1 disease; three of them had a recurrence and required subsequent laser treatment. Two of type 2 ROP infants (zone 2 stage 3 ROP without plus disease) were treated by laser, and the other 2 infants (zone 1 stage 1 ROP without plus disease) regressed without treatment. Four infants of severe ROP progressed to stage 4/5 ROP. Three of them (stage 4a, 4b, 5) occurred during 2017-2018 and only one stage 4A ROP was referred out after that.

The mean postmenstrual age at the last visit for infants without ROP was 43.0 ± 4.0 weeks and for infants with ROP was 46.9 ± 5.8 weeks. No life-threatening condition or intraocular infection was reported following ROP examination/treatment.

The risk factors associated with developing any stage of ROP were described in Table 3 GA ≤ 30 weeks (OR = 4.4; 95%CI = 1.0-18.4, p = 0.045) and hypoglycemia (OR = 0.1; 95%CI = 0.0-0.4, p = 0.002) showed significant correlation with ROP. While the significant risk factors associated with severe ROP (shown in table 4) were duration of endotracheal intubation of more than 30 days (OR = 17.9; 95%CI = 1.8-180.8, p = 0.015) and inguinal hernia (OR = 15.8; 95%CI = 1.4-177.1, p = 0.025)

Table 3 Analysis for risk factors of any stage of ROP (n = 142)

Risk characteristics	No ROP n (%)	Any ROP n (%)	Crude OR	P-value	Adjusted OR	P-value
GA				< 0.001		0.045
≤ 30 weeks	38 (45.2%)	46 (54.8%)	7.6 (3.2–17.9)		4.4 (1.0-18.4)	
> 30 weeks	50 (86.2%)	8 (13.8%)	1		1	
BW (g)				0.005		0.382
≤ 1500 g	65 (56.0%)	51 (44.0%)	6.0 (1.7-21.2)		2.1 (0.4-10.7)	
> 1500 g	23 (88.5%)	3 (11.5%)	1		1	

Table 3 Analysis for risk factors of any stage of ROP (n = 142) (continued)

Risk characteristics	No ROP n (%)	Any ROP n (%)	Crude OR	P-value	Adjusted OR	P-value
Duration of oxygen supplement (n = 135)				< 0.001		0.287
0-30 days	48 (84.2%)	9 (15.8%)	1		0.5 (0.1-1.9)	
more than 30 days	37 (47.4%)	41 (52.6%)	5.9 (2.6-13.7)		1	
Duration of ETT (n = 135)				< 0.001		0.241
0-10 days	74 (77.9%)	21 (22.1%)	1		1	
11-30 days	7 (30.4%)	16 (69.6%)	8.1 (2.9-22.6)		3.1 (0.7-13.9)	
more than 30 days	4 (23.5%)	13 (76.5%)	11.5 (3.4-38.8)		3.5 (0.6-22.2)	
Pulmonary complications				0.004		0.183
Yes	65 (55.6%)	52 (44.4%)	9.2 (2.1-40.8)		4.0 (0.5-29.9)	
No	23 (92%)	2 (8%)	1		1	
PDA				0.001		0.145
Yes	32 (47.8%)	35 (52.2%)	3.2 (1.6-6.5)		0.40 (0.1-1.4)	
No	56 (74.7%)	19 (25.3%)	1		1	
Brain complications				0.001		0.624
Yes	18 (41.9%)	25 (58.1%)	3.4 (1.6-7.1)		1.4 (0.4-5.3)	
No	70 (70.7%)	29 (29.3%)	1		1	
NEC				0.536		
Yes	25 (58.1%)	18 (49.1%)	1.3 (0.6-2.6)			
No	63 (63.6%)	36 (36.4%)	1			
Anemia requiring transfusion (n = 130)				< 0.001		0.145
Yes	45 (50.6%)	44 (49.4%)	7.0 (2.5-19.6)		2.9 (0.7-11.8)	
No	36 (87.8%)	5 (12.2%)	1		1	
Thrombocytopenia requiring transfusion (n = 130)				0.002		0.176
Yes	10 (37.0%)	17 (63.0%)	4 (1.6-9.6)		2.7 (0.6-11.7)	
No	72 (69.9%)	31 (30.1%)	1		1	
Hyperglycemia				NA		
Yes	4 (100%)	0 (0%)	NA			
No	84 (60.9%)	54 (39.1%)				
Hypoglycemia				0.026		0.002
Yes	22 (81.5%)	5 (18.5%)	0.3 (0.1-0.9)		0.1 (0.0-0.4)	
No	66 (57.4%)	49 (42.6%)	1		1	
Pneumonia				0.001		0.239
Yes	19 (42.2%)	26 (57.8%)	3.4 (1.6-7.1)		2.1 (0.6-7.4)	
No	69 (71.1%)	28 (28.9%)	1		1	
Urinary tract infection				0.02		0.046
Yes	13 (43.3%)	17 (56.7%)	2.7 (1.2-6.0)		3.7 (1.0-13.1)	
No	75 (67.0%)	37 (33.0%)	1		1	
Meningitis				0.203		
Yes	7 (46.7%)	8 (53.3%)	2.0 (0.7-5.9)			
No	81 (63.8%)	46 (36.2%)	1			
Sepsis				0.111		
Yes	73 (59.3%)	50 (40.7%)	2.6 (0.8-8.2)			
No	15 (78.9%)	4 (21.1%)	1			

Table 3 Analysis for risk factors of any stage of ROP (n = 142) (continued)

Risk characteristics	No ROP n (%)	Any ROP n (%)	Crude OR	P-value	Adjusted OR	P-value
Inguinal hernia				0.006		0.467
Yes	4 (26.7%)	11 (73.3%)	5.4 (1.6-17.9)		1.9 (0.3-11.2)	
No	84 (66.1%)	43 (33.9%)	1		1	
Osteopenia				0.004		0.412
Yes	10 (37%)	17 (63%)	3.6 (1.5-8.6)		1.8 (0.5-7.1)	
No	78 (67.8%)	37 (32.2%)	1		1	
Surgery under GA				0.001		0.447
Yes	9 (32.1%)	19 (67.9%)	4.8 (2.0-11.6)		2.0 (0.4-10.9)	
No	79 (69.3%)	35 (30.7%)	1		1	
Betablockers				0.272		
Yes	4 (44.4%)	5 (55.6%)	2.1 (0.6-8.4)			
No	84 (63.2%)	49 (36.8%)	1			

Abbreviations: BW, birthweight; ETT, endotracheal intubation; g, gram; GA, gestational age; GA, general anesthesia; IVH, intraventricular hemorrhage; n, number; NA, not available; NEC, necrotizing enterocolitis; OR, odd ratio; PDA, patent ductus arteriosus; ROP, retinopathy of prematurity

Binary logistic regression, significant level at $p < 0.05$, adjusted for GA, BW, duration of oxygen supplement, duration of ETT, pulmonary complications, PDA, brain complications, anemia requiring transfusion, thrombocytopenia requiring transfusion, hypoglycemia, pneumonia, urinary tract infection, inguinal hernia, osteopenia, surgery under GA

Table 4 Analysis for risk factors of severe treatment-requiring ROP (n = 114)

Risk characteristics	No ROP n (%)	Severe ROP n (%)	Crude OR	P-value	Adjusted OR	P-value
GA				0.001		0.293
≤ 30 weeks	38 (60.3%)	25 (39.7%)	32.9 (4.3-253.7)		4.1 (0.3-55.6)	
> 30 weeks	50 (98%)	1 (2%)	1		1	
BW (g)				NA		
≤ 1500 g	65 (71.4%)	26 (28.6%)	NA			
> 1500 g	23 (100%)	0 (0%)				
Duration of oxygen supplement (n = 109)				0.001		0.942
0-30 days	48 (98.0%)	1 (2.0%)	1		1	
more than 30 days	37 (61.7%)	23 (38.3%)	29.8 (3.9-231.2)		0.90 (0.1-14.7)	
Duration of ETT (n = 135)				< 0.001		
0-10 days	74 (94.9%)	4 (5.1%)	1		1	
11-30 days	7 (43.8%)	9 (56.3%)	23.8 (5.8-97.4)		7.06 (0.8-60.2)	0.074
more than 30 days	4 (26.7%)	11 (73.3%)	50.9 (11.1-233.5)		17.9 (1.8-180.8)	0.015
Pulmonary complications				NA		
Yes	65 (71.4%)	26 (28.6%)	NA			
No	23 (100%)	0 (0%)				
PDA				< 0.001		0.109
Yes	32 (58.2%)	23 (41.8%)	13.4 (3.7-48.2)		4.9 (0.7-34.5)	
No	56 (94.9%)	3 (5.1%)	1		1	
Brain complications				< 0.001		0.225
Yes	18 (54.5%)	15 (45.5%)	5.3 (2.1-13.5)		3.2 (0.5-21.1)	
No	70 (86.4%)	11 (13.6%)	1		1	

Table 4 Analysis for risk factors of severe treatment-requiring ROP (n = 114) (continued)

Risk characteristics	No ROP n (%)	Severe ROP n (%)	Crude OR	P-value	Adjusted OR	P-value
NEC				0.044		0.964
Yes	25 (65.8%)	13 (34.2%)	2.5 (1.0-6.2)		1.0 (0.2-5.7)	
No	63 (82.9%)	13 (17.1%)	1		1	
Anemia requiring transfusion (n = 106)				0.005		
Yes	45 (65.3%)	24 (34.8%)	19.2 (2.5-148.8)			
No	36 (97.3%)	1 (2.7%)	1			
Thrombocytopenia requiring transfusion (n = 106)				0.002		0.504
Yes	10 (50%)	10 (50%)	5.1 (1.8-14.7)		1.9 (0.3-12.4)	
No	72 (83.7%)	14 (16.3%)	1		1	
Hyperglycemia				NA		
Yes	4 (100%)	0 (0%)	NA			
No	84 (76.4%)	26 (23.6%)				
Hypoglycemia				0.156		
Yes	22 (88%)	3 (12%)	0.39 (0.1-1.4)			
No	66 (74.2%)	23 (25.8%)	1			
Pneumonia				0.001		0.167
Yes	19 (55.9%)	15 (44.1%)	5.0 (2.0-12.5)		3.6 (0.6-21.7)	
No	69 (86.3%)	11 (13.8%)	1		1	
Urinary tract infection				0.158		
Yes	13 (65.0%)	7 (35.0%)	2.1 (0.8-6.1)			
No	75 (79.8%)	19 (20.2%)	1			
Meningitis				0.041		0.925
Yes	7 (53.8%)	6 (46.2%)	3.5 (1.1-11.5)		1.1 (1.0-12.7)	
No	81 (80.2%)	20 (19.8%)	1		1	
Sepsis				0.252		
Yes	73 (75.3%)	24 (24.7%)	2.5 (0.5-11.6)			
No	15 (88.2%)	2 (11.8%)	1			
Inguinal hernia				< 0.001		0.025
Yes	4 (30.8%)	9 (69.2%)	11.1 (3.1-40.3)		15.8 (1.4-177.1)	
No	84 (83.2%)	17 (16.8%)	1		1	
Osteopenia				< 0.001		0.486
Yes	10 (45.5%)	12 (54.5%)	6.7 (2.4-18.4)		2.0 (0.3-14.9)	
No	78 (84.8%)	14 (15.2%)	1		1	
Surgery under GA				< 0.001		0.382
Yes	9 (45.0%)	11 (55.0%)	6.4 (2.3-18.2)		0.4 (0.0-3.5)	
No	79 (84.0%)	15 (16.0%)			1	
Betablockers				0.532		
Yes	4 (66.7%)	2 (33.3%)	1.8 (0.3-10.1)			
No	84 (77.8%)	24 (22.2%)	1			

Abbreviations: BW, birthweight; ETT, endotracheal intubation; g, gram; GA, gestational age; GA, general anesthesia; IVH, intraventricular hemorrhage; N, number; NA, not available; NEC, necrotizing enterocolitis; OR, odd ratio; PDA, patent ductus arteriosus; ROP, retinopathy of prematurity

Binary logistic regression, significant level at $p < 0.05$, adjusted for GA, duration of oxygen supplement, duration of ETT, PDA, brain complications, thrombocytopenia requiring transfusion, pneumonia, meningitis, inguinal hernia, osteopenia, surgery under GA

DISCUSSION

The different patients' conditions and neonatal care in each hospital may affect the incidence and outcomes of ROP. There are many complicated newborn cases at the Faculty of Medicine, Vajira hospital which is the tertiary referral center in Bangkok, Thailand. The incidence of ROP in this study was 38% of the screened infants. Young GA (≤ 30 weeks), hypoglycemia, duration of endotracheal intubation (≥ 30 days) and inguinal hernia were associated with ROP development. Most ROPs were spontaneously regressed or resolved after treatment. Only a few of them were referred for retinal surgery.

The incidence of ROP in Thailand varies from 10-40%[5-10]. When compared to the same type of hospitals, Queen Sirikit National Institute of Child Health, the biggest children's hospital in Thailand, had similar ROP incidences as our study that were approximately 40%[5-6]. While the incidence at Siriraj Hospital, the biggest tertiary hospital in Thailand, was only 14%[7]. Even though the mean GA of ROP infants at Siriraj Hospital was 27.2 weeks which was close to our ROP infants, there must be some dissimilar factors contributing to ROP development.

Both GA and BW were proven for associated with ROP by systematic review and meta-analysis studies[11-12]. In this study, we found only GA was associated with ROP infants. Infants who were born early or at 30 weeks had 4.36 times more risk of developing ROP. While low birthweight (≤ 1500 g) appeared to be significant. But after adjusting with other factors, it was found no difference between 2 groups (no ROP vs ROP).

In the aspect of oxygen supplement, it is mainly involved in the pathophysiology of ROP. So, infants who had respiratory problems and required oxygen therapy were susceptible to ROP. However, after adjusting these respiratory related factors, we found only the duration of mechanical ventilation was strongly significant with severe ROP. Infants who needed endotracheal intubation more than 1 month had 17.9 times more risk of developing severe ROP. These oxygen-related factors were not reported in the Siriraj study and its ROP incidence was quite low. We hypothesized that oxygen saturation control may differ in each hospital.

Inguinal hernia is one of the common problems in preterm infants. After 32 weeks of gestational age, the testicles go down into the scrotum followed by the contraction of processus vaginalis at the inguinal canal. Infants who are born prematurely have a greater risk of developing this condition and the lower GA has a higher risk. Brooker et al. reported the association of inguinal hernia and mechanical support[13]. They proposed that prolonged increased intraabdominal pressure from a respiratory ventilator may push a force on the inguinal canal and cause an inguinal hernia. In this study, we discovered that inguinal hernia was associated with severe ROP with 15.80 times more risk. Although inguinal hernia is not involved in the ROP development, the association between inguinal hernia and ROP may be explained by its association with mechanical ventilation which we also identified as one of the ROP risk factors

Recently, some studies suggested that hyperglycemia was associated with the risk of developing ROP[14-16]. Hyperglycemia played an important role in retinal blood flow and vascular endothelial growth factor (VEGF) which impacted angiogenesis and vascular permeability[17]. In this study, we had a small number of infants with hyperglycemia, so we cannot conclude this correlation. On the other hand, we found hypoglycemia as a protective factor for developing ROP but only a small effect (OR = 0.1; 95%CI = 0.0-0.4). No studies have ever suggested a correlation between hypoglycemia and ROP development. Further studies are required.

Beta-blockers have been introduced to the role of ROP prevention given that beta-2 receptors are involved in the regulation of VEGF levels. Nevertheless, the systematic review showed limited evidence of beta-blockers as prophylactics and there was no significant effect of oral beta-blockers

on ROP progression[18]. This study showed similar results that beta-blockers were not related to ROP development.

According to our current ROP screening guideline which we have applied the AAO screening policy, we examined all preterm infants who were born at GA ≤ 30 weeks or BW ≤ 1500 g. Every ROP infant in this study was born at GA ≤ 30 weeks or BW ≤ 1500 g. Furthermore, the incidence of ROP infants whose GA or BW were above the criteria was about 10 percent and all of them spontaneously regressed. Therefore, the AAO screening criteria are applicable to our hospital.

Most treatment-requiring ROP was treated by laser photocoagulation and successfully regressed. Some zone 1 ROP infants were treated by intravitreal anti-VEGF but many of them recurred when the duration of the drug subsided. Therefore, a close follow-up examination was necessary if anti-VEGF had been applied.

The limitation of this study was the number of subjects, which may have affected the statistical interpretation. Also, there may be some variations in diagnosis and treatment among examiners. Further, some data were difficult to retrieve, such as the fraction of inspired oxygen (FIO2), which may be inconsistent, and the hematological value of anemia, which varied depending on the gestational age of the preterm infants. Future studies are planned as the conditions of infants may differ from the current situation.

CONCLUSION

The overall ROP incidence was 38%. Even though a majority of the ROP patients recovered, recognizing possible factors helped in ROP detection and progression awareness.

CONFLICT OF INTEREST

The authors report no conflicts of interest for this article.

ACKNOWLEDGEMENT

This research was fully supported by the Navamindradhiraj University Research Fund.

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

REFERENCES

1. Wongkittirux K. Blindness, low vision and eye diseases in Thai children 2006-2007. J Health Sys Res 2012;6(4):501-12.
2. Fierson WM. Screening examination of premature infants for retinopathy of prematurity. Pediatrics 2018;142(6): e20183061.
3. International Committee for the Classification of Retinopathy of Prematurity. The international classification of retinopathy of prematurity revisited. Arch Ophthalmol 2005;123(7): 991-9.
4. Early Treatment For Retinopathy Of Prematurity Cooperative Group. Revised indications for the treatment of retinopathy of prematurity: results of the early treatment for retinopathy of prematurity randomized trial. Arch Ophthalmol 2003; 121(12):1684-94.
5. Thitiratsanont U, Wutthiworavong B, Supangkasen I, Keyurapan B, Saowaprut Ch, Amphornphruet A. Screening for retinopathy of prematurity in Queen Sirikit National Institute of Child Health: Bangkok, Thailand. Thai J Ophthalmol 2011;25:9-16.
6. Bowe T, Nyamai L, Ademola-Popoola D, Amphornphruet A, Anzures R, Cernichiaro-Espinosa LA, et al. The current state of retinopathy of prematurity in India, Kenya, Mexico, Nigeria, Philippines, Romania, Thailand, and Venezuela. Digit J Ophthalmol 2019;25(4):49-58.
7. Chutasmit K, Wongsiride P, Sommai K, Siriwaeo S, Insawang P, Kitsommart R. Incidence and risk factors of retinopathy of prematurity, a 10-year experience of a single-center, referral, hospital. Siriraj Med J 2021;73(12):777-85.

8. Thongthong K. Prevalence and risk factors for retinopathy of premature infants in KamPhaeng Phet Hospital. Reg 11 Med J 2018;32(4):1261-8.
9. Duangsang S. Incidence and factors associated with retinopathy of prematurity (ROP) in Roiet Hospital. Srinagarind Med J 2017; 32(1):10-6.
10. Saleewan Kh. Incidence and risk factors of retinopathy of prematurity. Med J Srisaket Surin Buriram Hosp 2016;31(2):99-110.
11. Azami M, Jaafari Z, Rahmati S, Farahani AD, Badfar G. Prevalence and risk factors of retinopathy of prematurity in Iran: a systematic review and meta-analysis. BMC Ophthalmol 2018;18(1):83.
12. Yu CW, Popovic MM, Dhoot AS, Arjmand P, Muni RH, Tehrani NN, et al. Demographic risk factors of retinopathy of prematurity: a systematic review of population-based studies. Neonatology 2022;119(2):151-63.
13. Brooker RW, Keenan WJ. Inguinal hernia: relationship to respiratory disease in prematurity. J Pediatr Surg 2006;41(11):1818-21.
14. Lei C, Duan J, Ge G, Zhang M. Association between neonatal hyperglycemia and retinopathy of prematurity: a meta-analysis. Eur J Pediatr 2021;180(12):3433-42.
15. Almeida AC, Silva GA, Santini G, Brízido M, Correia M, Coelho C, et al. Correlation between hyperglycemia and glycated albumin with retinopathy of prematurity. Sci Rep 2021; 11(1):22321.
16. Ahmadpour-Kacho M, Motlagh AJ, Rasoulinejad SA, Jahangir T, Bijani A, Pasha YZ. Correlation between hyperglycemia and retinopathy of prematurity. Pediatr Int 2014;56(5):726-30.
17. Mohamed S, Murray JC, Dagle JM, Colaizy T. Hyperglycemia as a risk factor for the development of retinopathy of prematurity. BMC Pediatr 2013;13:78.
18. Kaempfen S, Neumann RP, Jost K, Schulzke SM. Beta-blockers for prevention and treatment of retinopathy of prematurity in preterm infants. Cochrane Database Syst Rev;3(3):CD011893.