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Research Article

Retinopathy of Prematurity and Its Association with Oxygen Therapy in Preterm Low Birth Weight Babies

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A B S T R A C T

*Background:*Retinopathy of prematurity (ROP) is a vasoproliferative disorder of the developing retinal vasculature and remains an important cause of preventable childhood blindness among preterm infants. Prematurity, low birth weight, and exposure to oxygen therapy are recognized as major risk factors for the development of ROP. Early identification of high-risk neonates is essential for timely intervention and prevention of visual impairment.

Objectives: To evaluate the incidence of retinopathy of prematurity and its association with oxygen therapy in preterm low birth weight babies.

Materials and Methods: This hospital-based observational study was conducted in the Neonatal Intensive Care Unit of a tertiary care hospital. A total of 40 preterm low birth weight neonates were included in the study. Data regarding demographic characteristics, birth weight, gestational age, and duration of oxygen therapy were recorded. All neonates underwent ophthalmologic screening for ROP using indirect ophthalmoscopy. The association between oxygen therapy and the occurrence of ROP was analyzed using appropriate statistical methods.

Results: Out of the 40 neonates included in the study, 24 (60%) were males and 16 (40%) were females. Retinopathy of prematurity was detected in 11 neonates (27.5%), while 29 neonates (72.5%) did not develop ROP. A higher incidence of ROP was observed among neonates who received oxygen therapy for longer durations, indicating a significant association between prolonged oxygen exposure and the development of ROP.

Conclusion: The study highlights that prematurity, low birth weight, and prolonged oxygen therapy are important risk factors for the development of retinopathy of prematurity. Proper monitoring of oxygen therapy and early ophthalmologic screening in high-risk neonates are essential to reduce the incidence and prevent complications of ROP.

Keywords: Retinopathy of prematurity, Preterm infants, Low birth weight, Oxygen therapy, Neonatal intensive care unit, Neonatal blindness

Introduction

Retinopathy of prematurity (ROP) is a potentially blinding disorder that primarily affects preterm and low birth weight infants, and its association with oxygen therapy has been recognized for several decades. Early studies demonstrated that excessive oxygen exposure plays a significant role in the development of ROP. Tin et al. reported a lower incidence of ROP in infants whose oxygen saturation levels were maintained between 70%–90% compared to those maintained between 88%–98%[1]. The susceptibility of the developing retinal vasculature to hyperoxia has been attributed to the unique anatomical and developmental relationship between the retinal and choroidal circulation. The choroidal vessels supply the outer half of the retina through diffusion and are characterized by higher permeability, elevated venous oxygen tension (PaO_2), and a limited capacity for autoregulation in response to hyperoxia.[2,3] As oxygen tension increases across the retinal layers, the retinal vessels undergo vasoconstriction, which may disrupt normal vascular development.However, the optimal oxygen saturation target for preterm infants remains controversial. A meta-analysis by Askie and Henderson-Smart, which included five randomized controlled trials evaluating different oxygen saturation targets in preterm infants, was unable to determine an optimal range for maintaining PaO_2 levels that would minimize the risk of ROP while ensuring adequate systemic oxygenation[4]. The Supplemental Therapeutic Oxygen for Prethreshold Retinopathy of Prematurity (STOP-ROP) trial was conducted to evaluate whether increasing oxygen saturation could reduce the progression from prethreshold to threshold ROP[5]. In this study, infants were assigned either to a standard oxygen saturation group (89%–95%) or to a higher saturation group (96%–99%). Although a trend toward improved ocular outcomes was observed in the lower saturation group, infants in this group experienced significantly more pulmonary complications, required longer durations of oxygen therapy, and had extended hospital stays. Furthermore, studies examining the impact of gradual versus abrupt weaning of oxygen therapy have not demonstrated significant differences in the incidence of ROP[6].In this context, careful monitoring and optimization of oxygen therapy remain critical in the management of preterm low birth weight infants to minimize the risk of ROP while preventing systemic complications. Therefore, the present study was undertaken to evaluate the association between oxygen therapy and the development of retinopathy of prematurity in preterm low birth weight babies.

Materials and Methods

Study Design and Setting

This hospital-based observational study was done in department of paediatrics. The study included preterm low birth weight neonates admitted to the NICU during the study period who met the inclusion criteria. A total of 40 preterm infants were enrolled in the study.The sample size consisted of 40 preterm low birth weight babies admitted to the NICU during the study period and fulfilling the inclusion criteria.

Inclusion Criteria

Preterm neonates with gestational age less than 37 weeks. Neonates with birth weight less than 2500 grams. Neonates who required oxygen therapy during their NICU stay. Parents or guardians who provided informed consent for participation in the study.

Exclusion Criteria

- Neonates with major congenital anomalies
- Neonates with congenital ocular abnormalities.
- Neonates who expired before ophthalmological screening.
- Neonates whose parents or guardians did not provide consent.

Data Collection

Detailed maternal and neonatal information was collected using a structured proforma. Maternal variables included age, antenatal history, and obstetric complications. Neonatal variables included gestational age, birth weight, sex, Apgar score, duration of oxygen therapy, mode of oxygen delivery, and other clinical parameters.

Oxygen Therapy Assessment

Information regarding oxygen therapy was recorded for each neonate, including the type of oxygen support such as nasal prongs, continuous positive airway pressure (CPAP), or mechanical ventilation. The duration of oxygen exposure and oxygen saturation levels were monitored and documented throughout the NICU stay.

Ophthalmological Examination

All enrolled neonates underwent retinal examination by a qualified ophthalmologist using indirect ophthalmoscopy after pupillary dilatation with appropriate mydriatic agents. Screening for retinopathy of prematurity was performed according to standard screening guidelines. ROP was classified based on the International Classification of Retinopathy of Prematurity.

Outcome Measures

The primary outcome measured was the presence or absence of retinopathy of prematurity. The association between oxygen therapy and the occurrence of ROP among preterm low birth weight infants was evaluated.

Statistical Analysis

Data collected were entered into Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics such

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as mean, standard deviation, frequency, and percentage were used to summarize the data. The association between oxygen therapy variables and the occurrence of ROP was assessed using appropriate statistical tests such as the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 40 preterm low birth weight neonates admitted to the NICU were included in the study to evaluate the association between oxygen therapy and the development of retinopathy of prematurity (ROP).

Demographic Characteristics

The study population consisted predominantly of male neonates. Out of 40 babies, 24 (60%) were males and 16 (40%) were females, as shown in Table 1.

Table 1.Sex Distribution of Study Population (n = 40)

Sex	Number (n)	Percentage (%)
Male	24	60
Female	16	40
Total	40	100

Birth Weight Distribution

The majority of neonates belonged to the birth weight group of 1500–2000 g. Distribution of neonates according to birth weight is presented in Table 2.

Table 2.Distribution According to Birth Weight

Birth Weight (g)	Number (n)	Percentage (%)
<1000	4	10
1000–1499	14	35
1500–2000	18	45
>2000	4	10
Total	40	100

Incidence of Retinopathy of Prematurity

Out of the 40 preterm infants screened, retinopathy of prematurity was detected in 11 neonates (27.5%), while 29 neonates (72.5%) did not develop ROP. This distribution is shown in Table 3.

Table 3.Incidence of Retinopathy of Prematurity

ROP Status	Number (n)	Percentage (%)
ROP Present	11	27.5
ROP Absent	29	72.5
Total	40	100

Association between Oxygen Therapy Duration and ROP

The incidence of ROP was found to be higher among neonates who received oxygen therapy for longer durations. Among infants who received oxygen therapy for more than 7 days, a higher proportion developed ROP compared to those who received oxygen for shorter durations. This association is presented in Table 4.

Table 4.Association between Duration of Oxygen Therapy and ROP

Duration of Oxygen Therapy	ROP Present (n)	ROP Absent (n)	Total
≤ 7 days	3	17	20
> 7 days	8	12	20
Total	11	29	40

Chi-square test was applied to assess the association between duration of oxygen therapy and the occurrence of retinopathy of prematurity.

Overall, retinopathy of prematurity was observed in 27.5% of preterm low birth weight infants included in the study. A higher incidence of ROP was noted among infants receiving prolonged oxygen therapy, indicating a possible association between duration of oxygen exposure and the development of ROP.

Discussion

Retinopathy of prematurity (ROP) is a vasoproliferative disorder affecting the developing retinal vasculature of premature infants and remains an important cause of preventable childhood blindness worldwide. The disease occurs due to interruption of normal retinal vascular development followed by abnormal neovascularization, which in severe cases may progress to retinal detachment and permanent visual impairment. The condition was first described by Terry in 1942, and subsequent studies established a strong association between oxygen therapy and the development of ROP.[8,9] Early investigations demonstrated that excessive oxygen exposure contributed significantly to retinal vascular injury, and later studies suggested that inspired oxygen concentrations greater than 40% were associated with a higher risk of ROP.[10–13] Advances in neonatal intensive care during the 1960s improved survival of extremely premature infants; however, this also led to a resurgence in ROP due to increased survival of vulnerable neonates and liberal oxygen administration.[14] Currently, with improved monitoring and judicious oxygen therapy, the incidence of severe ROP has decreased in developed countries, although it still remains an important public health issue in developing regions.[15–18]

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In the present study, a total of 40 preterm low birth weight neonates admitted to the NICU were evaluated to determine the association between oxygen therapy and the development of retinopathy of prematurity. The demographic distribution of the study population showed a predominance of male neonates (60%) compared to females (40%), as shown in Table 1. Similar gender distributions have been reported in several neonatal studies; however, gender itself is generally not considered a strong independent risk factor for ROP.

The overall incidence of ROP in the present study was 27.5%, as shown in Table 3. This incidence is comparable with several recent studies conducted in similar neonatal populations. Earlier reports, such as the study by Rekha et al., reported a relatively higher incidence of ROP, whereas more recent studies by Gupta et al. and Chowdhury et al. documented incidence rates closer to the findings of the present study.[22–24] The variation in incidence across studies may be attributed to differences in neonatal care practices, improvements in oxygen monitoring, and variations in screening criteria and neonatal survival rates.

Low birth weight and prematurity are well-established risk factors for the development of ROP.[19,20] In the present study, the majority of neonates belonged to the 1500–2000 g birth weight group, as shown in Table 2. However, a higher proportion of ROP cases occurred among infants with lower birth weight, supporting the observation that the risk of ROP increases with decreasing birth weight and gestational age. Similar findings were reported by Freeman et al. and Kistner et al., who demonstrated a significantly higher prevalence of ROP among infants weighing less than 1000 grams.[20,27] The increased susceptibility in these infants may be due to the immaturity of retinal vasculature and increased vulnerability to fluctuations in oxygen tension.

Gestational age is another important determinant of ROP development. Studies have shown that the incidence of ROP increases with decreasing gestational age.[21] In previous research by Saeidi et al., the prevalence of ROP was significantly higher among neonates born before 28 weeks of gestation, with statistical significance.[25] These findings were comparable with the observations reported by Hakeem et al. and Karna et al., which also highlighted prematurity as a major risk factor for the disease.[21,26] Extremely premature infants have incomplete retinal vascularization at birth, making them more susceptible to oxygen-induced vascular injury and subsequent pathological neovascularization.

The present study also demonstrated an association between oxygen therapy duration and the occurrence of ROP. As shown in Table 4, neonates who received oxygen therapy for more than 7 days had a higher incidence of ROP compared to those receiving oxygen for shorter durations. This observation is consistent with previous studies that have emphasized the role of prolonged oxygen exposure as an important contributing factor for ROP development. Askie et al., through the NeOProM study, also reported that higher levels of oxygenation were associated with an increased risk of ROP morbidity.30 The pathophysiological mechanism behind this association involves hyperoxia-induced vasoconstriction of retinal vessels, leading to cessation of normal vascular growth and subsequent abnormal neovascularization when relative hypoxia occurs. Mechanical ventilation and prolonged respiratory support have also been reported as significant risk factors for ROP in several studies. Previous investigations by Freeman et al., Shah et al., and Mokhtari et al. demonstrated a strong association between mechanical ventilation, duration of ventilation, and the development of ROP.27–29 The requirement for prolonged respiratory support often reflects the severity of prematurity and respiratory distress, which indirectly increases the risk of retinal vascular injury.Blood transfusion has been identified as a potential risk factor for ROP in some studies. Hassel et al. and Banerjee et al. reported a significant association between blood transfusion and the development of ROP, possibly due to increased oxygen delivery and oxidative stress.31,32 However, the present study did not demonstrate a statistically significant association between blood transfusion and ROP. This finding may be due to the relatively small sample size of the study population.Similarly, apnoea has been reported as a contributing factor for the development of ROP in some studies. Investigations by Chattopadhyay et al. and Aggarwal et al. identified apnoea as a significant risk factor, possibly due to intermittent hypoxia and fluctuations in oxygen levels affecting retinal vascular development.33,34 However, in the present study, no significant association between apnoea and ROP was observed. The absence of statistical significance may again be attributed to the limited sample size and variability in clinical characteristics of the neonates.

Conclusion

The present study demonstrated that retinopathy of prematurity (ROP) remains an important complication among preterm low birth weight neonates. The overall incidence of ROP in the study population was 27.5%. Prematurity, low birth weight, and prolonged oxygen therapy were identified as significant factors associated with the development of ROP. The findings emphasize the need for careful monitoring of oxygen therapy and early ophthalmological screening in high-risk neonates to reduce the risk of ROP and prevent vision-threatening complications.

Limitations

The present study had certain limitations. The sample

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size was relatively small (n = 40), which may limit the generalizability of the findings. The study was conducted at a single tertiary care center, which may not represent the broader neonatal population. Additionally, some potential risk factors such as blood transfusion and apnoea could not show significant association, possibly due to the limited sample size. Larger multicentric studies are required to further validate these findings.

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