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Original Research Article

A STUDY ON INCIDENCE AND CORRELATION OF RISK FACTORS OF RETINOPATHY OF PREMATURITY IN TERTIARY CARE SNCU/NICU, MGM HOSPITAL WARANGAL

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ABSTRACT

Background: Retinopathy of Prematurity (ROP) is a potentially blinding vasoproliferative retinal disorder affecting premature and low birth weight infants. Advances in neonatal intensive care have improved survival of preterm neonates, leading to an increased incidence of ROP worldwide. Early identification of risk factors and timely screening are essential for preventing visual disability and blindness. The aim is to study the incidence of Retinopathy of Prematurity and correlate the associated neonatal risk factors among preterm infants admitted to the SNCU/NICU of MGM Hospital, Warangal.

Materials and Methods: This prospective observational study was conducted in the SNCU/NICU and Department of Ophthalmology, MGM Hospital, Warangal, over a period of 18 months. Preterm infants with gestational age ≤34 weeks and birth weight ≤2000 g admitted to the NICU were included in the study. Detailed neonatal history, systemic risk factors, oxygen therapy duration, sepsis, blood transfusion, respiratory distress syndrome, and other associated variables were recorded. Ophthalmological screening was performed by indirect ophthalmoscopy after pupillary dilatation according to standard ROP screening guidelines. Statistical analysis was performed using the Chi-square test and logistic regression. A p-value <0.05 was considered statistically significant.

Results: The incidence of ROP among screened neonates was found to be significant. Low gestational age, low birth weight, prolonged oxygen therapy, respiratory distress syndrome, neonatal sepsis, blood transfusion, and mechanical ventilation showed a strong association with the development of ROP. Severe ROP was more commonly observed among neonates with birth weight below 1500 g and gestational age less than 32 weeks.

Conclusion: Retinopathy of Prematurity remains an important cause of preventable childhood blindness in premature infants. Low birth weight, prematurity, prolonged oxygen exposure, and neonatal systemic complications are significant risk factors for ROP development. Early screening and timely ophthalmic intervention are essential to reduce visual morbidity in high-risk neonates.

Keywords: Retinopathy of Prematurity, Prematurity, Low Birth Weight, Neonatal Intensive Care Unit, Oxygen Therapy, Risk Factors, Blindness Prevention.

INTRODUCTION

Retinopathy of Prematurity (ROP) is a developmental vasoproliferative disorder of the immature retina occurring predominantly in premature and low birth weight infants. It is considered one of the leading causes of preventable childhood blindness worldwide. ROP develops due to incomplete retinal vascularization in premature infants followed by abnormal retinal neovascularization after birth. The disease may progress from mild retinal changes to severe retinal detachment and permanent blindness if not diagnosed and treated at an early stage.[1]

The global incidence of prematurity has increased significantly during the past few decades due to improvements in neonatal intensive care and survival of extremely premature infants. Advances in neonatal care, surfactant therapy, mechanical ventilation, and oxygen supplementation have improved survival rates among preterm infants, especially in developing countries such as India. However, increased survival has also contributed to a rising incidence of ROP, leading to what is described as the "third epidemic" of ROP blindness in middle-income countries.[2]

ROP is primarily a disease of retinal vascular immaturity. Normal retinal vascularization begins at approximately 16 weeks of gestation and is completed near term. Premature birth interrupts this process, leaving peripheral retina avascular. Exposure of the immature retina to fluctuating oxygen levels after birth suppresses vascular endothelial growth factor (VEGF), resulting in cessation of normal retinal vessel growth. Subsequent retinal hypoxia stimulates abnormal neovascularization which characterizes ROP.[3]

Several studies have identified low gestational age and low birth weight as the two strongest independent risk factors for development of ROP.[4] The risk of severe ROP increases significantly with decreasing gestational age and lower birth weight. According to Kaur et al., every additional week of gestational age and every increase in birth weight significantly reduce the probability of developing threshold ROP.[4] Extremely low birth weight infants and very preterm neonates are therefore considered the highest-risk group requiring mandatory ophthalmological screening.

In addition to prematurity and low birth weight, several neonatal and systemic factors contribute to the pathogenesis of ROP. Prolonged oxygen therapy remains one of the most important modifiable risk factors associated with retinal neovascularization and disease progression.[5] Unregulated oxygen supplementation can cause retinal hyperoxia followed by hypoxia-induced angiogenesis. Mechanical ventilation, respiratory distress syndrome, bronchopulmonary dysplasia, neonatal sepsis, intraventricular hemorrhage, anaemia, apnoea, and repeated blood transfusions have also been associated with increased risk of ROP development.[6]

Recent studies have emphasized the multifactorial nature of ROP. De las Rivas Ramírez et al. reported that ROP progression depends not only on prematurity and birth weight but also on multiple prenatal and postnatal factors including infection, systemic instability, oxygen fluctuation, and nutritional deficiencies.[7] Di Pietro et al. observed that prolonged assisted ventilation, patent ductus arteriosus, and multiple births significantly influence disease severity and progression.[8]

The incidence of ROP varies considerably between developed and developing countries, depending on neonatal care practices, screening protocols, and survival rates of premature infants. In developed countries, ROP mainly affects extremely premature infants weighing less than 1000 g. In contrast, in developing countries, larger and more mature infants may also develop severe ROP due to variations in neonatal monitoring and oxygen administration.[9] India currently contributes a significant burden to global ROP-related blindness due to increasing preterm survival and inadequate screening coverage in certain regions.

Timely screening and early detection are essential for prevention of blindness caused by ROP. Standard screening guidelines recommend ophthalmological examination of infants with low gestational age and low birth weight admitted in NICU settings. Screening is generally performed using indirect ophthalmoscopy after pupillary dilatation beginning at 3–4 weeks of postnatal age depending on gestational maturity.[10] Early stages of ROP may regress spontaneously, whereas severe disease may require laser photocoagulation, cryotherapy, or anti-VEGF therapy.

Recent advances in retinal imaging and artificial intelligence have significantly improved ROP screening and diagnosis. Digital retinal imaging systems and teleophthalmology are increasingly used for screening in resource-limited settings.[11] AI-based diagnostic systems using deep learning algorithms have demonstrated promising accuracy in identifying and grading ROP from retinal images. Ramanathan et al. reported that artificial intelligence-based ROP diagnosis systems improve screening efficiency and reduce interobserver variability among ophthalmologists.[12] AI-enabled smartphone retinal imaging has also shown significant potential in low-resource neonatal screening programs.[13]

Despite improvements in neonatal care, ROP continues to remain a major challenge in developing countries. Lack of awareness, delayed referral, inadequate screening infrastructure, shortage of trained ophthalmologists, and poor follow-up contribute to preventable blindness among preterm infants. Early identification of high-risk neonates and correlation of associated risk factors are essential for developing effective screening strategies and improving neonatal care protocols.

Several studies from India have reported varying incidence rates of ROP depending on regional neonatal practices and patient characteristics. Sankar et al. observed that low gestational age, prolonged oxygen therapy, and neonatal systemic complications were strongly associated with severe ROP in preterm infants admitted to NICU settings.[14] Similar findings have been reported by multiple Indian and international studies emphasizing the importance of vigilant neonatal monitoring and early ophthalmic screening.[15]

MGM Hospital, Warangal, serves as a major tertiary care referral center with specialized SNCU/NICU facilities managing high-risk preterm neonates from surrounding districts. Due to increasing survival of premature infants, there is a growing need to evaluate the burden of ROP and identify associated risk factors in this region. Understanding the local epidemiological pattern of ROP is essential for planning preventive strategies, improving neonatal care practices, and reducing visual morbidity.

The present study was therefore undertaken to determine the incidence of Retinopathy of Prematurity and evaluate the correlation between neonatal risk factors and development of ROP among preterm infants admitted in the SNCU/NICU of MGM Hospital, Warangal.

Aim

To determine the incidence of Retinopathy of Prematurity and evaluate the correlation between neonatal risk factors and development of ROP among preterm infants admitted in SNCU/NICU, MGM Hospital, Warangal.

Objectives

1. To determine the incidence of Retinopathy of Prematurity among preterm neonates admitted in SNCU/NICU.
2. To evaluate the association between gestational age and development of ROP.
3. To assess the correlation between low birth weight and occurrence of ROP.
4. To study the role of oxygen therapy, mechanical ventilation, neonatal sepsis, respiratory distress syndrome, and blood transfusion as risk factors for ROP.
5. To identify neonates at high risk for severe ROP requiring timely ophthalmological intervention.

MATERIALS AND METHODS

The present study was conducted as a prospective observational study in the Special Newborn Care Unit (SNCU/NICU) and Department of Ophthalmology, MGM Hospital, Warangal, over a period of 18 months from January 2023 to June 2024. Institutional Ethics Committee approval was obtained before commencement of the study. Written informed consent was obtained from the parents or guardians of all neonates included in the study.

A total of 120 preterm neonates admitted to SNCU/NICU were screened for Retinopathy of Prematurity (ROP). Neonates with gestational age less than or equal to 34 weeks and birth weight less than or equal to 2000 grams were included in the study. Neonates who required oxygen supplementation, mechanical ventilation, or prolonged NICU stay were also included. Neonates with congenital ocular anomalies, congenital cataract, corneal opacity, severe systemic instability preventing ophthalmic examination, or parents refusing consent were excluded from the study.

The sample size was calculated using the prevalence formula:

[n = \frac{Z^2 \times p \times q}{d^2}]

where:

- (n) = sample size
- (Z) = standard normal variate at 95% confidence interval (1.96)
- (p) = estimated prevalence of ROP (8%)
- (q = 1-p)
- (d) = allowable error (5%)

Substituting the values:

[n = \frac {(1.96) ^2 \times 0.08 \times 0.92} {(0.05) ^2}]

[n = \frac {3.84 \times 0.0736} {0.0025}]

[n = 113.0]

The sample size was approximately 120 neonates.

The variables included in the study were gestational age, birth weight, gender, oxygen therapy duration, respiratory distress syndrome (RDS), neonatal sepsis, blood transfusion, mechanical ventilation, apnoea episodes, and duration of NICU stay. These variables were selected based on previously established risk factors associated with ROP development.

A detailed neonatal history was recorded from SNCU/NICU records. Birth weight was measured using calibrated neonatal weighing scales. Gestational age was calculated based on the maternal last menstrual period and confirmed using the New Ballard Scoring system.

All neonates underwent a detailed ophthalmological examination. Pupillary dilatation was achieved using 0.5% tropicamide and 2.5% phenylephrine eye drops instilled one hour before examination. Indirect ophthalmoscopy was performed using a binocular indirect ophthalmoscope with a 20D lens under aseptic precautions. Retinal findings were documented according to the International Classification of Retinopathy of Prematurity guidelines.

The ophthalmological examination evaluated retinal vascularization, demarcation lines, ridge formation, neovascularization, plus disease, and retinal detachment. The disease was classified into Stage 1, Stage 2, Stage 3, Stage 4, and Stage 5 ROP. Zone involvement and extent of retinal disease were also documented.

Neonates diagnosed with severe ROP requiring intervention were referred for laser photocoagulation

or anti-VEGF therapy according to standard treatment guidelines.

The major examination tools used in the study included neonatal weighing scales, pulse oximeter monitoring systems, oxygen delivery systems, mechanical ventilators, binocular indirect ophthalmoscopes, 20D retinal examination lens, neonatal retinal imaging systems, and NICU monitoring equipment.

Indirect ophthalmoscopy findings revealed peripheral retinal avascularity, demarcation lines, ridge formation, retinal neovascularization, and plus disease in neonates diagnosed with ROP. Severe disease was more commonly observed in extremely premature infants with prolonged oxygen exposure and systemic instability.

Statistical analysis was performed using SPSS software version 25.0. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were calculated. Chi-square test was used to analyze categorical variables and determine the association between risk factors and ROP occurrence. Student's t-test was applied for comparison of continuous variables. Logistic regression analysis was performed to identify independent predictors of ROP development. A p-value less than 0.05 were considered statistically significant.

RESULTS

The present study included 120 preterm neonates admitted to SNCU/NICU. Ophthalmological screening was performed according to standard ROP screening protocols. The table demonstrates the incidence of ROP among the screened neonates.

Inference: The incidence of Retinopathy of Prematurity in the present study was 26.7%.

Table 1: Incidence of Retinopathy of Prematurity

ROP Status	Number of Neonates	Percentage (%)
ROP Present	32	26.7
ROP Absent	88	73.3

Gestational age was analyzed as one of the major determinants for the development of ROP. Lower gestational age was associated with a higher incidence and severity of disease. The table demonstrates the distribution of neonates according to gestational maturity.

Inference: Neonates with gestational age less than 30 weeks showed significantly higher incidence of ROP.

Table 2: Distribution According to Gestational Age

Gestational Age	ROP Present	ROP Absent
<30 Weeks	15	10
30–32 Weeks	10	28
>32 Weeks	7	50

Birth weight was strongly associated with occurrence of ROP in the study population. Extremely low birth weight infants demonstrated increased disease severity. The table shows correlation between birth weight and ROP occurrence.

Inference: Lower birth weight significantly increased the risk of ROP development.

Table 3: Distribution According to Birth Weight

Birth Weight	ROP Present	ROP Absent
<1000 g	12	5
1000–1500 g	14	25
>1500 g	6	58

Oxygen supplementation remains one of the major modifiable risk factors in ROP pathogenesis. Prolonged oxygen exposure was more common among neonates who developed ROP. The table shows the association between oxygen therapy duration and ROP occurrence.

Inference: Prolonged oxygen therapy beyond 7 days showed a strong association with ROP development.

Table 4: Oxygen Therapy Duration

Oxygen Therapy Duration	ROP Present	ROP Absent
<3 Days	5	45
3–7 Days	12	28
>7 Days	15	15

Respiratory distress syndrome was evaluated as an important neonatal complication associated with prematurity. Neonates with RDS frequently require prolonged oxygen therapy and ventilatory support.

The table demonstrates the association between RDS and ROP.

Inference: Respiratory distress syndrome significantly increased the occurrence of ROP.

Table 5: Respiratory Distress Syndrome (RDS)

RDS Status	ROP Present	ROP Absent
Present	22	30
Absent	10	58

Neonatal sepsis contributes to systemic instability and inflammatory changes in premature infants. The incidence of ROP was higher among neonates diagnosed with sepsis. The table shows correlation between neonatal sepsis and ROP.

Inference: Neonatal sepsis showed a significant association with ROP development.

Table 6: Neonatal Sepsis

Sepsis Status	ROP Present	ROP Absent
Present	18	20
Absent	14	68

Blood transfusion was evaluated as a contributing neonatal risk factor. Repeated transfusions were more common among critically ill preterm neonates.

The table demonstrates the relationship between blood transfusion and ROP occurrence.

Inference: Neonates receiving blood transfusions showed an increased risk of ROP.

Table 7: Blood Transfusion

Blood Transfusion	ROP Present	ROP Absent
Received	20	22
Not Received	12	66

Mechanical ventilation is commonly required in extremely premature infants with respiratory complications. Longer ventilatory support was associated with increased retinal vascular complications. The table demonstrates the relationship between mechanical ventilation and ROP.

Inference: Mechanical ventilation was significantly associated with development of ROP.

Table 8: Mechanical Ventilation

Mechanical Ventilation	ROP Present	ROP Absent
Required	24	26
Not Required	8	62

The findings of the present study were compared with previous published studies evaluating incidence and risk factors of ROP. Similar associations with prematurity, low birth weight, oxygen therapy, and systemic neonatal complications were observed.

Inference: The findings of the present study are comparable with previous national and international studies.

Comparative Study Table

Author	Year	Incidence-of ROP	Major Risk Factors
Azad et al,[2]	2020	22%	Low birth weight, oxygen therapy
de las Rivas Ramírez et al,[7]	2022	28%	Sepsis, prematurity, ventilation
Choudhary et al,[15]	2023	24%	RDS, oxygen exposure
Sankar et al,[14]	2025	27%	Prematurity, blood transfusion
Present Study	2025	26.7%	Low birth weight, oxygen therapy, sepsis

DISCUSSION

Retinopathy of Prematurity is a major preventable cause of childhood blindness affecting premature and low birth weight infants worldwide. The increasing survival of preterm neonates due to advances in neonatal intensive care has resulted in a growing burden of ROP, particularly in developing countries such as India. Early identification of risk factors and timely screening remain essential for prevention of visual disability.

The present study demonstrated an incidence of ROP of 26.7% among preterm neonates admitted in SNCU/NICU. Similar incidence rates have been reported in previous Indian studies. Sankar et al. reported an incidence of 27% among high-risk premature infants admitted in tertiary care NICU settings.[14] Choudhary et al. also observed incidence rates ranging from 20–30% depending on neonatal risk profiles and screening criteria.[15] Variations in incidence may be related to differences in neonatal

care practices, oxygen monitoring, and survival rates of extremely premature infants.

Low gestational age was identified as one of the strongest risk factors associated with ROP in the present study. Neonates with gestational age less than 30 weeks demonstrated significantly higher disease occurrence. Similar findings have been reported by Zhang et al., who concluded that retinal vascular immaturity in extremely premature infants increases susceptibility to abnormal neovascularization and retinal hypoxia.[5] Kaur et al. also emphasized that decreasing gestational age significantly increases risk of severe ROP requiring treatment.[4]

Low birth weight was another major independent predictor of ROP development in the present study. Neonates weighing less than 1000 grams showed highest disease incidence. Premature infants with extremely low birth weight possess incomplete retinal vascularization and greater systemic instability, predisposing them to retinal vascular complications.[16] Chen et al. reported that low birth weight remains one of the most consistent predictors of severe ROP worldwide.[6]

Prolonged oxygen therapy showed strong association with ROP occurrence in the present study. Oxygen supplementation beyond seven days significantly increased disease risk. Oxygen-induced suppression of vascular endothelial growth factor followed by hypoxia-driven angiogenesis is considered a major pathogenic mechanism in ROP.[17] Fierson emphasized the importance of careful oxygen monitoring and saturation control in premature neonates to minimize retinal vascular injury.[10]

Respiratory distress syndrome and mechanical ventilation were also significantly associated with ROP in the present study. Neonates requiring ventilatory support often experience fluctuating oxygenation and systemic instability contributing to retinal ischemia and neovascularization. Di Pietro et al. demonstrated that prolonged assisted ventilation and pulmonary complications significantly increase risk of threshold ROP.[8]

Neonatal sepsis was another important systemic risk factor identified in the study. Systemic inflammation, cytokine release, and vascular endothelial injury associated with sepsis may contribute to abnormal retinal vascular development.[18] de las Rivas Ramírez et al. reported that neonatal infection and inflammatory mediators significantly influence progression and severity of ROP.[7]

Blood transfusion also showed significant correlation with ROP occurrence in the present study. Repeated transfusions may increase oxidative stress and retinal free radical injury in premature infants.[19] Similar observations have been reported by Sumer et al., who identified transfusion-related oxidative stress as an important contributing factor in severe ROP development.[9]

Recent advances in retinal imaging and artificial intelligence have improved screening and diagnosis of ROP. AI-assisted retinal image analysis systems are increasingly being utilized for automated ROP grading and teleophthalmology screening programs.[12] Ramanathan et al. demonstrated that deep learning-based AI systems improve diagnostic accuracy and reduce interobserver variability in retinal screening.[12] AI-enabled screening may be particularly useful in rural and resource-limited settings where trained ophthalmologists are not readily available.

Digital retinal imaging systems have further improved documentation and monitoring of retinal changes in preterm neonates. Ortiz et al. demonstrated that smartphone-based retinal imaging integrated with AI algorithms can significantly improve screening accessibility in developing countries.[13] Such innovations may help reduce preventable blindness associated with delayed diagnosis.

Several studies have emphasized the importance of standardized ROP screening programs in tertiary care neonatal centers. Jalali et al. reported that implementation of strict neonatal screening guidelines significantly reduces the incidence of advanced ROP-related blindness.[20] Proper NICU protocols regarding oxygen monitoring, infection control, and neonatal stabilization are essential preventive strategies.

The present study findings emphasize the multifactorial nature of ROP development. Prematurity, low birth weight, oxygen exposure, respiratory complications, sepsis, and blood transfusion act synergistically in influencing retinal vascular pathology. Early identification of high-risk neonates allows timely ophthalmological evaluation and intervention before progression to irreversible retinal detachment.

Although the present study provides important insights into ROP risk factors in the Warangal region, larger multicentric studies are required for broader epidemiological assessment. Long-term follow-up studies evaluating visual outcomes after treatment may provide additional understanding regarding disease progression and rehabilitation outcomes.

CONCLUSION

Retinopathy of Prematurity remains a significant preventable cause of childhood blindness among premature neonates. Low gestational age, low birth weight, prolonged oxygen therapy, respiratory distress syndrome, sepsis, blood transfusion, and mechanical ventilation were major risk factors associated with disease development. Early screening, strict neonatal monitoring, and timely ophthalmological intervention are essential to reduce visual morbidity and improve long-term outcomes in high-risk preterm infants.

Limitations of the study

The present study was limited by single-center design and relatively small sample size. Long-term visual outcomes after treatment were not assessed. Advanced retinal imaging and AI-assisted grading systems were not available for all neonates. Larger multicentric studies with long-term follow-up are required for better evaluation of disease progression and treatment outcomes.

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