Refractive status in Nepalese preterm and full term infants early in life

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Statement of Significance

This study suggests that preterm infants, even without retinopathy of prematurity, are at risk for abnormal refractive development and informs the need for close monitoring of refractive error in such infants, regardless of their retinopathy of prematurity status.

Purpose

To investigate the refractive error trend in Nepalese preterm infants without retinopathy of prematurity (ROP) in the first 6 months of life and explore the association of refractive error with birth weight (BW) and gestational age (GA).

Methods

Thirty-six preterm infants without ROP and 40 full term infants underwent cycloplegic retinoscopy at birth, term (for preterm only), 3 months and 6 months chronologically. Refractive status was classified into emmetropia (mean spherical equivalent refraction (SER) 0 to +3.00 D), myopia (SER<0.00 D) and significant hyperopia (SER>+3.00 D). Refractive parameters at various age points were compared between the preterm and full term infants using General Linear Model Repeated Measures ANOVA.

Results

At birth, the SER in the preterm infants was +0.84±1.72 D, however, there was a shift towards myopia at six months of age (SER=-0.33±1.95D). There was a significant difference in SER, astigmatism, and anisometropia between preterm and full term infants by 6 months of age (p<0.01). Astigmatism and anisometropia showed an increasing trend with age in preterm infants (p<0.05 at 6 months) in contrast to a decreasing trend in full term infants (p<0.05 at three and six months). In preterm infants, there was a statistically significant positive relationship between GA and SER ((β=0.32, R^2= 17.6%, p<0.05) but a negative relationship between BW and astigmatism (β= -1.25, R^2= 20.6%, p<0.01).

Conclusion

Preterm infants, that do not develop ROP, show a trend towards increasing myopia, and demonstrate greater astigmatism and anisometropia than full term infants in their first six months of life.

Keywords: Refractive error; preterm, myopia; birth weight; gestational age

With the introduction of advanced neonatal life support systems, the survival of preterm neonates has significantly increased in the recent years.[1] However, the survival often comes at the expense of a large number of neuro-developmental handicaps that develop secondary to the complications of prematurity.[2,3] Numerous ocular health challenges are also associated with prematurity. Children who are born premature are at greater risk of having morbid ocular conditions, including retinopathy of prematurity[4-6] and refractive error[7,8]. Moreover, eyes exhibiting retinopathy of prematurity continue to present with signs of myopia, and the degree, as well as frequency of myopia occurrence, is known to be related to retinopathy of prematurity status.[9] However, prematurity itself has been reported to be a precursor of refractive error development in preterm infants.[10, 11]

Uncorrected refractive error in infants can lead to abnormal visual development resulting in amblyopia and strabismus associated with poor cognitive development and socio-economic consequences.[12,13] Longitudinal studies on full term infants indicate that refractive status varies with age.[14,15] While full term new born infants are known to be hyperopic at birth[16-18], there has been a bias towards both hyperopia and myopia in preterm infants.[17,18] Verma et al studied the refractive status of preterm infants at the age of six months and found that none of them were emmetropic.[19] Further studies have demonstrated a higher incidence of myopia, astigmatism, and anisometropia in preterm infants than full term infants when examined at an age corresponding to term and later.[20-23] It has been previously shown that the refractive disorders, such as myopia, astigmatism, and anisometropia, are common in preterm infants with or without retinopathy of prematurity.[20,24-26] In addition, preterm infants who develop retinopathy of prematurity have been found to be myopic when examined near term.[27] These evidences, taken together, suggest that preterm infants are at risk for abnormal refractive development.

The magnitude of myopic refractive error in preterm infants decreases as gestational age increases.[28] Besides gestational age, low birth weight and the duration of oxygen exposure are known to be clinical

risk factors for ocular morbidities in preterm infants.[29,30] It has previously been suggested that birth weight instead of gestational age should be used for screening of refractive error.[30] However, reports have also indicated a lack of relationship between birth weight and the refractive status.[31] Therefore, the association of the clinical risk factors, such as birth weight and gestational age with refractive status in preterm infants is yet to be fully understood.

Most of the aforementioned studies have examined refractive status in preterm infants at a specific age early in life or began measurements after three months of age. There is a paucity of data about concurrent longitudinal changes in the refractive state early in the life of premature infants. In addition, discrepancies still exist regarding the relationship of refractive error in infancy to various clinical risk factors, such as birth weight and gestational age in preterm infants. To the best of our knowledge, there are no published reports on the refractive error trend in Nepalese preterm infants without retinopathy of prematurity. The objectives of this study were to investigate the longitudinal changes in the refractive state of preterm infants in the first six months of life and to explore the association of refractive parameters with birth weight and gestational age. In addition, we sought to study the differences in refractive state between preterm infants and their full term counterparts.

Subjects and Methods

This prospective, hospital-based study included 71 preterm infants. Fifty out of the 71 preterm infants completed the follow-up; however, 14 infants were diagnosed as stage 1 retinopathy of prematurity either at term or later. Therefore, only 36 preterm infants without retinopathy of prematurity were included in the final analyses. Forty full term healthy infants served as the control group. The cohort of infants was recruited from the neonatal intensive care unit (NICU) of Tribhuvan University Teaching Hospital (TUTH) in Kathmandu, Nepal. Infants with incomplete or missing records were excluded from the study as were infants with retinopathy of prematurity, craniofacial or other major anomalies, infants in whom the reflex was not clearly ascertainable as well as those unfit for the long examination

necessary for the study. The study protocol adhered to the tenets of the Declaration of Helsinki. Institutional ethics committee approval and written informed parental consent were obtained.

The first examination was carried out at the NICU of TUTH within one week of birth for both preterm and full term infants. Patient particulars were noted from the medical record file which included a profile of birth history, the age of gestation, birth weight and duration of oxygen exposure. The infants were then referred for follow-up examinations to the Paediatric Ophthalmology Clinic at BP Koirala Lions Center for Ophthalmic Studies (BPKLCOS) where subsequent examinations were carried out at term (±1 week) (for preterm only), three months (±1 week) and six months (±1 week) chronologically. An experienced pediatric ophthalmologist screened the infants for retinopathy of prematurity at the first as well as subsequent visits. All the refractive examinations in preterm and full term infants were performed by a single pediatric optometrist throughout the study duration. Because the data were highly correlated between the two eyes (data not shown), only right eye (OD) data were included in the study.[32] However, we also investigated the difference in mean spherical equivalent refraction between the two eyes to analyze for anisometropia.

Anterior segment evaluation was carried out with a torch light examination. For cycloplegia and paralysis of accommodation, 1% tropicamide and 2.5% phenylephrine eye drops were used twice, one drop in each eye at an interval of 15 minutes. Eyelids were retracted using infant wire eye speculum (K 1-5350). Fundus examination was done with a binocular indirect ophthalmoscope with a 20 D auxiliary lens and scleral indentation. Retinoscopy was performed by streak retinoscopy at least 30 minutes after the instillation of the last drop using a lens bar as well as handheld lenses. The retinoscopic reflex was assessed for variability and the refraction was determined only after the reflex appeared stable. The mean spherical equivalent refractive error was determined as the sum of the spherical value and half of the cylindrical amount in dioptres (D).

Based on gestational age, preterm infants were classified into extremely preterm (<28 weeks), very preterm (28 to <32 weeks) and moderate to late preterm (32 to <37 weeks).[33] Infants were further

classified as low birth weight (1.5 to <2.5kg), very low birth weight (1 to <1.5kg) and extremely low birth weight (<1 kg).[33] Retinopathy of prematurity was classified according to the international classification of retinopathy of prematurity criteria.[34] Infants were divided into three groups based on their spherical equivalent refractive error. Emmetropia was defined as 0 to +3.00 D mean spherical equivalent refraction, myopia as less than 0 D mean spherical equivalent refraction and significant hyperopia as more than +3.00 D mean spherical equivalent refraction. Significant astigmatism was defined as ≥1.00 D and significant anisometropia as ≥1.00 D difference in the spherical equivalent between two eyes.[21] Astigmatism was classified into with-the-rule astigmatism (WTR), positive cylinder axis 90˚ (± 15˚), that is, vertical meridian having greater refractive power than the horizontal meridian, against-the-rule astigmatism (ATR), positive cylinder axis 180˚(± 15˚), that is, horizontal meridian having greater refractive power than the vertical meridian and oblique astigmatism, all other cylinder axes.[21]

Statistical analyses were done using SPSS v20.0 (SPSS Inc., Chicago, Illinois). Descriptive statistics (mean, SD, range) were used to describe the measure and spread of continuous variables in our sample. Repeated measures ANOVA was conducted for each outcome (spherical equivalent refraction, astigmatism, and anisometropia) with a between subjects factor (study group with 2 levels), a within-subject factor (age with four levels) and one interaction term (group*age). Linear regression was used to evaluate the relationship of birth weight and gestational age with mean spherical equivalent refraction at birth. Fisher's exact test was used in the analysis of contingency tables. A *P* value <0.05 was considered statistically significant.

Results

The various characteristics of 36 preterm and 40 full term infants are shown in Table 1. Gestational age of preterm infants ranged from 28 to 36 weeks with a mean age of 32.9 (SD=2.23) weeks. Out of 36 preterm neonates, 25 (69.4%) as low birth weight and 11 (30.6%) as very low birth weight. The

mean weight of preterm infants at birth was 1.63 kg (SD=0.30) while that of full term infants was 3.49 kg (SD=0.48).

Distribution of refractive error

The distribution of the refractive status was determined on the basis of spherical equivalent refractive error according to the pre-set criteria[21]. At birth, 69.4% of the preterm infants had emmetropia, 25.0% had myopia, and 5.6% had significant hyperopic as shown in Table 2. The mean spherical equivalent refractive error for these infants at birth was +0.84D (SD=1.72) (Table 4). However, there was a shift towards myopia by 6 months of age with a mean spherical equivalent refractive error of -0.33D (SD=1.95) (Table 4) with half of the infants (50.0%) in the myopia category. This was not true for full term infants in which 95.0% of them were emmetropic at birth with a mean spherical equivalent refraction of +2.19D (SD=0.66) and all of these infants were emmetropic by 6 months of age (Table 2 and 5). Astigmatism was equally likely to occur in preterm infants and full term infants at birth (Fisher exact test, p=0.199) and when present, the majority of infants had ATR astigmatism (36.1% and 35.0% in preterm and full term infants respectively) (Table 3).

Refractive development in the first six months of life

The results from the RM ANOVA with a between subjects factor (study group with 2 levels), a within-subject factor (age with 4 levels), and interaction term (between group*age) with post hoc testing are presented in Tables 4-6 (Table 4: within preterm; Table 5: within full term; Table 6: between group comparisons at each time point). There was a significant main effect of age on spherical equivalent refraction (p<0.001) with no significant interaction between age and study group. Multiple comparisons using Bonferroni correction showed a significant difference in mean spherical equivalent refraction from birth to 3 months (p<0.001) as well as from birth to 6 months (p<0.001) in preterm infants. There was also a statistically significant difference in spherical equivalent refraction of full term infants from birth to three months (p<0.001), birth to six months (p<0.001) as well as three months to six months (p<0.001). Both astigmatism (p<0.005) and anisometropia (p<0.05) showed an

increasing trend and differed significantly between age points of preterm infants. However, post hoc analysis revealed differences in astigmatism and anisometropia which were significant only between birth and six months ($p<0.05$). There was also a statistically significant difference in astigmatism when compared between different age points in full term infants ($p<0.001$). However, a significant decrease in anisometropia was noted only between birth and six months ($p<0.05$) as well as three months and six months ($p<0.01$) in full term infants (Table 4 and 5).

Comparison of refractive parameters between full term and preterm infants over time

We also compared all the refractive parameters between preterm and full term infants at different chronological age points. There was a significant effect of study groups (preterm vs full term) on spherical equivalent refraction at birth ($p<0.001$), term ($p<0.001$), three months ($p<0.001$) and six months ($p<0.001$) (Table 6). With an increase in age, there was also an increase in the difference in astigmatism and anisometropia between preterm and full term infants (Figure 1). A statistically significant difference in astigmatism was noted between preterm and full term infants at three months ($p<0.01$) and six months ($p<0.001$). In contrast, a difference in anisometropia was present between preterm and full term infants only at six months ($p<0.01$) (Table 6).

Relationship of refractive parameters in preterm infants with birth weight and gestational age

We performed linear regression analysis to evaluate the relationship of gestational age and birth weight with spherical equivalent refraction, astigmatism, and anisometropia in preterm infants at birth. Gestational age was significantly related to spherical equivalent refraction explaining around 18% of the variation (β=0.32, R^2= 17.6%, $p<0.05$) whereas, there was a weak relationship between spherical equivalent refraction and birth weight (β= 1.45, R^2= 6.5%, p=0.133) (Figure 2). Interestingly, there was a moderate negative statistically significant relationship between birth weight and astigmatism (β=-1.25, R^2= 20.6%, $p<0.01$) with approximately 20.0% of variations in astigmatism being explained by birth weight. However, a poor relationship was established between

gestational age and astigmatism (β=-0.05, R^2= 1.9%, p=0.420) (Figure 3). Both birth weight and gestational age were poorly related to anisometropia in preterm infants at birth (R^2= 0.7%, p=0.619 and R^2= 3.3%, p=0.290 respectively).

Discussion

Ocular morbidities are common sequelae following premature birth. Emmetropization often fails in preterm infants who develop retinopathy of prematurity, resulting in high levels of refractive error and a myopic bias.[35, 36] Due to clinical risk factors such as birth weight and gestational age, prematurity might also signal abnormal refractive development independent of retinopathy of prematurity status at an early stage of life. In an effort to elucidate the trend of refractive development in preterm infants without retinopathy of prematurity, we measured refractive errors longitudinally in a cohort of Nepalese preterm infants and their full term counterparts in the first 6 months of life. In addition, we explored the relationship between refractive error at birth with clinical risk factors, such as birth weight and gestational age in the preterm infants. The findings of this study indicate that 1) preterm infants, although without retinopathy of prematurity, are likely to be at risk for abnormal refractive development early in life with a greater magnitude of myopia, astigmatism, and anisometropia than the full term infants, and 2) younger infants (based on gestational age) and infants with low birth weights are likely to be born with greater magnitude of myopia and astigmatism, respectively.

Distribution of refractive error

In our study, the prevalence of myopia in preterm infants increased from birth to six months with 50.0% having myopia (mean spherical equivalent refraction <0 D) at 6 months compared to 25.0% at birth. In contrast, nearly all of the full term infants had emmetropia (mean spherical equivalent refraction 0 to 3.00 D) throughout the six-month study period (At birth: 95.0%, At six months: 100%). We found a much lower prevalence of hyperopia in preterm infants than has been reported

previously (76.8%[8], 66.6-70%[19]). This difference in refractive error prevalence in preterm infants might be due to several reasons. Firstly, our study set a criterion for refractive error classification regarding significant hyperopia as >+3.00 D in accordance with previously used limits. Although it is not explicitly clear what criteria were used in the previous studies, it is likely that the conventional way of classifying refractive error (hyperopia>1.00 D) might have resulted in a greater prevalence of hyperopic refractive error in previous studies. Secondly, cyclopentolate was used to achieve cycloplegia in the aforementioned studies. While it is difficult to attribute the lower prevalence of hyperopia found in our study solely to the use of a different cycloplegic drug (tropicamide) as both of these agents have been reported to yield similar results in healthy infants[43], we are not able to completely rule out this possibility. Thirdly, there are ethnic differences between the infants across these studies (Nepalese, Indian and Israeli cohorts) and refractive outcomes are known to vary with ethnicity.[37, 38] In a multicenter, longitudinal observational study of refractive error prevalence in four ethnic groups, Kleinstein et al noted a significant difference in refractive error prevalence as a function of ethnicity (Chi-square test, p<.001) even after controlling for age and sex.[37] Although we are not aware of any studies involving Nepalese infants that allow direct comparisons to our findings, the ethnic variations in prevalence of refractive error globally suggest that the differences across the various studies might well be attributed to ethnicity.

The cohorts of preterm and full term infants in our study were equally likely to have astigmatism at birth. These results corroborate the findings of previous works reported in the literature.[23, 30] Interestingly, we found that ATR astigmatism was more prevalent among astigmatic preterm infants, which is in agreement with a previous study of 59 preterm infants.[23] However, a large proportion of both preterm and full term infants were reported to have WTR astigmatism in a different study.[30] While the exact reasons for such discrepancy remain unclear, we speculate that the ethnic differences in study population, as mentioned earlier, might be a contributing factor.

Refractive development in the first six months of life

Prior studies that have evaluated refractive status in preterm infants report a wide range of values in the literature (+0.87 to -1.54 D). [46,47,48] We found a mean spherical equivalent refraction of +0.82 D in our cohort of preterm infants at term, which compares favorably with values reported by Cook et al (+0.74 D)[46] at 40 weeks of postmenstrual age and Saunders et al (+0.87D)[23] at term. Interestingly, our finding differs from Gordon et al's report of -1.00 D[47] at between 35 and 40 weeks postmenstrual age and Fledelius report of -1.54 D[48] at term. However, it should be noted that there was a preponderance of younger infants (based on gestational age) in Gordon et al's study which might have resulted in a more myopic refractive error. Also, the refractive error data in Fledelius' study was a mathematical adjustment from a wider range of postmenstrual ages. Infants in Fledelius' study were examined between 36 and 54 weeks postmenstrual age and some of them had regressed stage 1 or 2 retinopathy of prematurity.

The analysis of refractive error as a function of age indicated a trend towards relative myopia as well as an increase in astigmatism and anisometropia in preterm infants. Although spherical equivalent refraction continued to show a relatively myopic trend in full term infants, astigmatism and anisometropia decreased in magnitude as the infants grew older. Our findings for full term infants are consistent with those of Saunders et al[23]; however, preterm infants showed a contrasting trend, as Saunders and colleagues, in their study, noted a decrease in all refractive parameters (spherical equivalent refraction, astigmatism, and anisometropia) from birth to six months.

Previous studies investigating refractive error distribution in full term infants have consistently reported moderate hyperopia using either atropine (Gernet: +2.75 D)[49] or cyclopentoalate (Luyckz: +2.40 D[50]; Saunders et al: +3.47 D[23] and Blomdahl: +3.60 D[51]) as cycloplegic agents. Consistent with these reports, we found moderate hyperopia (mean spherical equivalent refraction = +2.19 D) in full term infants at birth. The hyperopic error reduced with age and subsequently decreased to +1.06 D at six months— a trend similar to that reported previously by Saunders et al (+3.47 D at birth to +2.36 D at 6 months). Because infants' eyes are known to emmetropize with age and gradually develop towards a state of no refractive error, it is not surprising to see a decreasing trend in

hyperopia. However, we observed relatively low hyperopia in full term infants at all examination age points in compared to previous reports. As discussed previously, different ethnicities in the study cohorts (Asians in the present study vs Caucasians in Saunders et al's study) and to a lesser extent, the choice of cycloplegic drug might have contributed to the inconsistencies in the findings across studies. Further studies comparing full term and preterm infants for refractive differences in older populations might aid in our understanding of the mechanisms behind such differing trends.

Comparison of refractive parameters between full term and preterm infants over time

Preterm infants were relatively myopic when compared to their full term counterparts at all examination age points. At birth, preterm infants were more likely to have anisometropia and a greater astigmatism than their full term peers. These findings of the current study are similar to that reported by Saunders and colleagues in a Caucasian cohort.[23] However, in contrast to Saunders et al's study, the differences in refractive parameters (spherical equivalent refraction, astigmatism, and anisometropia) between preterm and full term infants also persisted at six months of age. Furthermore, there was a contrasting trend of refractive development with age between these two cohorts— Preterm infants showed a trend for increasing astigmatism and anisometropia, whereas full term infants showed the opposite trend with decreasing astigmatism and anisometropia. However, in both cohorts, there was an increase in relative myopia with age. Saunders et al, in their study, did not identify such differing trends of refractive development between preterm and full term infants throughout the six-month study period.[23] The authors, however, highlighted the differences in refractive parameters early (i.e. at birth and at term) and indicated that preterm and full term infants might differ in relation to their refractive development.[23]

Relationship of refractive parameters in preterm infants with birth weight and gestational age

In our study, younger preterm infants (in terms of gestational age) showed a higher degree of myopia suggesting that the degree of relative myopia at birth might be directly related to gestational age. This is in line with a previous study by Dobson et al[35], who reported an inverse relation between gestational

age and spherical equivalent refraction, with the youngest infants being more myopic. Because eye size in preterm infants tends to be smaller with lower gestational age, one might expect a hyperopic refractive error in younger preterm infants. However, it may well be that the reduced radius of curvature of refractive structures, such as cornea and lens might be the contributing factor for myopia in preterm infants early in life. Previous studies have suggested an increase in corneal curvature as a precursor to myopia associated with prematurity and a poor relation between axial length and refractive status at birth in premature infants.[39, 40] It should, however, be noted that such relationship between gestational age and myopia has not always been observed.[23] This was speculated to be due to the close association between birth weight and age, which might make it extremely difficult to discriminate between the effect of early birth and small size on refractive components.[23] Although, gestational age and astigmatism at birth were not associated in our study, there was a negative association between birth weight and astigmatism in preterm infants. This is in contrast to the previous report that gestational age correlates better with astigmatism than birth weight in preterm infants.[23] Furthermore, at birth, we did not see any association between either gestational age or birth weight with anisometropia. Because there are considerable differences in study cohorts across these studies and variations are likely to occur accordingly, these findings need to be interpreted with care. Moreover, there was a large variability in the data as evident from the scatterplots (Figure 2 and 3).

Limitations of the study

All 76 subjects participating in the study were Nepalese. Since refractive errors are known to vary with ethnicity, we are unable to generalize the results of this study to similar cohorts from ethnic groups other than of Nepalese origin. Furthermore, the cohort of infants recruited for the study was also limited by its sample size; hence, caution must be applied in extrapolating these findings. Additional studies with larger samples and diverse populations need to be undertaken to lend weight to these results. In order to ensure meaningful comparison of findings across studies, we implemented refractive error classification criteria previously used in studies investigating refractive development in preterm infants over a long period after birth (2- 3.5 years)[21,23]. However, it is

important to bear in mind these unconventional criteria when drawing inferences from the present study. Although, the refractive status of all infants at various age points was evaluated under cycloplegia, the combination of tropicamide and phenylephrine was used to achieve the cycloplegic effect instead of cyclopentolate— a cycloplegic drug of choice in children. The measurement of various biometric parameters, such as axial length and corneal curvatures would have potentially provided further insights on differences in refractive error outcomes between preterm and full term infants. However, these parameters were not measured as a part of this study. Although, both preterm and full term infants in our study were followed up for six months to observe the longitudinal changes, we are unable to determine how the refractive parameters would have continued to develop over the course of a longer critical period of development. Further studies need to be undertaken to determine whether the differences in refractive parameters between preterm infants and their full term counterparts in the first six months of life as observed in our study continues further progression as the infants grow older.

Conclusion

In summary, our study demonstrated that Nepalese preterm infants are at risk for abnormal refractive development with a trend towards increasing magnitude of ametropia (i.e. myopia, astigmatism and anisometropia). Such refractive trend is likely to occur in preterm infants even when they do not develop retinopathy of prematurity, and could present a major challenge to the developing visual system. It is, therefore, essential to monitor the preterm infants for refractive outcomes regardless of their retinopathy of prematurity state.

Conflict of Interest: None

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468 **Figure legends**

469 **Figure 1**. (a) Astigmatism (right eye) and (b) anisometropia in preterm and full term infants at
470 different age points. Error bars represent standard error of mean. The open circles (o) and dotted
471 lines (---) indicate values for full term infants whereas the filled circles (●) and continuous line (–)
472 indicate corresponding values for preterm infants. D represents dioptres.

473 **Figure 2**. Association between spherical equivalent refraction (SER) in right eye (OD) at birth and (a)
474 gestational age (in weeks) as well as (b) birth weight (in kg) in preterm infants. D represents
475 dioptres.

476 **Figure 3**. Association between astigmatism in right eye (OD) at birth and (a) gestational age (in weeks)
477 as well as (b) birth weight (in kg) in preterm infants. D represents dioptres.

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480 Table 1. Baseline statistics of the study population

	Preterm	Full term
N	36	40
M/F	14(38.9%)/22(61.1%)	16(40.0%)/24(60.0%)
Gestational age (weeks)		
28 to <32	10 (27.8%)	----
32 to <37	26 (72.2%)	----
37 or more	----	40 (100%)
Mean ±SD	32.89 ± 2.22	39.45 ± 1.38
Range	28.00 - 36.00	37.00 - 42.00
Birth weight (kg)		
<1.0	----	----
1.0 to <1.5	11 (30.6%)	----
1.5 to <2.5	25 (69.4%)	----
≥2.5	----	40 (100%)
Mean ±SD	1.63 ± 0.30	3.49 ± 0.48
Range	1.20 - 2.40	2.50 - 4.30

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Table 2. Classification of refractive error (right eye) in 36 preterm and 40 full term infants at birth, term (preterm only), 3 months and 6 months.

	Preterm n (%)				Full term n (%)		
	Birth	Term	3 months	6 months	Birth	3 months	6 months
Emmetropia (SER 0-3 D)	25 (69.4)	25 (69.4)	20 (55.6)	18 (50.0)	38 (95.0)	40 (100.0)	40 (100.0)
Myopia (SER <0 D)	9 (25.0)	9 (25.0)	16 (44.4)	18 (50.0)	----	----	----
Significant Hyperopia (SER >3 D)	2 (5.6)	2 (5.6)	----	----	2 (5.0)	----	----

Values are expressed as N (%); SER, spherical equivalent refraction

Table 3. Type of astigmatism (right eye) in preterm and full term infants.

	WTR n (%)	ATR n (%)	Oblique n (%)	No astigmatism n (%)
Preterm	10 (27.8)	13(36.1)	6 (16.7)	7 (19.4)
Full term	8 (20.0)	14 (35.0)	4 (10.0)	14 (35.0)

Fisher's exact test, $p<0.05$ (study groups vs presence of astigmatism)

Table 4. Refractive error in preterm infants at different chronological age points

	Birth	Term	3 months	6 months	P^1	P^2	P^3
SER (OD)	+0.84 ± 1.72 (-3.50 to +4.50)	+0.82 ± 1.72 (-3.50 to +4.50)	+0.21 ± 1.78 (-4.00 to +3.00)	-0.33 ± 1.95 (-5.00 to +2.50)	1.000	<0.001	<0.001
Astigmatism (OD)	1.11 ± 0.84 (0 to 3.00)	1.12 ± 0.85 (0 to 3.00)	1.25 ± 0.92 (0 to 3.25)	1.34 ± 0.98 (0 to 3.25)	1.000	0.117	<0.05
Anisometropia*	0.44 ± 0.64 (0 to 2.00)	0.45 ± 0.63 (0 to 2.00)	0.57 ± 0.71 (0 to 2.25)	0.68 ± 0.84 (0 to 3.00)	1.000	0.339	<0.05

Values are expressed as Mean ±SD (Range) in Dioptres; SER, spherical equivalent refraction; OD, right eye

P^1, birth vs term; P^2, birth vs 3 months; P^3, birth vs 6 months

*Relative difference in refractive error between the two eyes

Table 5. Refractive error in full term infants at different chronological age points.

	Birth	3 months	6 months	P^1	P^2	P^3
SER (OD)	+2.19 ± 0.66 (+1.00 to +3.50)	+1.70 ± 0.63 (+0.75 to +3.00)	+1.06 ± 0.68 (0 to +3.00)	<0.001	<0.001	<0.001
Astigmatism (OD)	0.79 ± 0.71 (0 to 2.00)	0.63 ± .57 (0 to 2.00)	0.51 ± 0.50 (0 to 2.00)	<0.001	<0.001	<0.01
Anisometropia*	0.40 ± 0.46 (0 to 1.75)	0.34 ± .33 (0 to 1.00)	0.26 ± 0.30 (0 to 1.00)	0.769	0.049	<0.01

Values are expressed as Mean ± SD (Range) in Dioptres; SER, spherical equivalent refraction; OD, right eye

P^1, birth vs 3 months; P^2, birth vs 6 months; P^3, 3 months vs 6 months

*Relative difference in refractive error between the two eyes

522 Table 6. Refractive error in preterm vs full term infants

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		Preterm	Full term	*P*
SER (OD)	Birth	+0.84 ± 1.72	+2.19 ± 0.66	<0.001
	Term	+0.82 ± 1.72	----	----
	3 months	+0.21 ± 1.78	+1.70 ± 0.63	<0.001
	6 months	-0.33 ± 1.95	+1.06 ± 0.68	<0.001
Astigmatism (OD)	Birth	1.11 ± 0.84	0.79 ± 0.71	0.072
	Term	1.12 ± 0.85	----	----
	3 months	1.25 ± 0.92	0.63 ± 0.57	<0.01
	6 months	1.34 ± 0.98	0.51 ± 0.50	<0.001
Anisometropia	Birth	0.44 ± 0.64	0.40 ± 0.46	0.726
	Term	0.45 ± 0.63	----	----
	3 months	0.65 ± 0.69	0.34 ± 0.33	0.069
	6 months	0.68 ± 0.84	0.26 ± 0.30	<0.01

524 Values are expressed as Mean ± SD in Dioptres; SER, spherical equivalent refraction; OD, right eye
525 Since the measures of refractive error are same for both birth and term age points for full term
526 infants, the corresponding data are presented for birth only, leaving empty cells for term

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