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Intraocular Pressure and Central Corneal Thickness in Premature and Full Term Newborns in Tertiary Health Care Centre Rural India

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ABSTRACT

Introduction- Central corneal thickness (CCT) and Introocular pressure (IOP) measurement plays an important role in diagnosis and treatment of various eye disorders. The aim of this study was to assess the correlation between central corneal thickness (CCT) and intraocular pressure (IOP) in both preterm and full-term babies. Additionally, the study aimed to compare the differences in IOP and CCT between premature and full-term newborns.

Material and methods- The present prospective observational study was conducted at pediatric ward and NICU of Pediatric department at a tertiary care hospital among 50 premature and full-term newborns during the study period of one year. Patients were divided into two groups i.e. group A and group B. Group A consist of premature newborn (gestational age<37 weeks) and Group B consist of fullterm newborn (gestational age>.37 week). Cases were selected on the basis of following inclusion and exclusion criteria. The mean values of intraocular pressure (IOP) and central corneal thickness (CCT) were compared using a one-way analysis of variance (ANOVA) test. A P value > 0.05 was considered statistically significant.

Results– Out of 50 cases 29 were premature and 21 were full term newborn. The mean age at measurement was 33 ± 2.1 and 38 ± 2 weeks and the comparison was statistically significant. The mean birth-weight was 1578±324 (grams) in pre mature and 2897±456 in full term (grams). The mean intraocular pressure (IOP) was 19.2 ± 3.3 mm Hg in premature newborns and 17.1 ± 2.4 mm Hg in full-term newborns. A t-test analysis showed a significant difference between the two groups (P = 0.001). The mean corneal curvature thickness (CCT) was 589 ± 35 mm in premature newborns and 568 ± 25 mm in full-term newborns

Conclusion– IOP readings in premature babies were somewhat higher compared to full-term newborns due to an elevated CCT (central corneal thickness).

Keywords: *central corneal thickness, full term, intraocular pressure, newborn, premature, retinopathy*

1. INTRODUCTION

There is a correlation between low birth weight and gestational age and systemic health problems and death rates in newborns. Preterm and low birth weight newborns often experience high levels of oxygen exposure, which increases their chances of developing retinopathy of prematurity (ROP) [1-3].

There is a fluid pressure within the eye that is referred to as intraocular pressure (IOP) or eye pressure. This pressure is maintained by the continuous generation and removal of fluids from the system. The pressure that is generated inside the eye is determined by the pressure that is exerted from the outside as well as the changes in the volume of the contents that are

contained within the eye. This is because the orbital globe can be viewed as a spherical rigid container. When it comes to volumes, the forces that are generated in a normal eye are mostly dictated by the dynamics of the aqueous humour (AH). IOP, like the majority of other biological parameters, is capable of exhibiting fluctuations and changes. Due to the fact that intraocular pressure (IOP) follows a diurnal cycle, levels are typically higher in the morning and lower in the evening.[3] It has been observed that the usual range of variation in intraocular pressure (IOP) in healthy persons is within 6 mm Hg, however deviations that are much higher than 10 mm Hg are considered to be abnormal. [4] There are a number of factors that have been described in the literature that might influence or cause differences in intraocular pressure (IOP). These factors include the kind of tonometer, genetics, age, race, season, posture, lifestyle, exercise, refractive error, obesity, general disorders, medicine, and so on.[5]

In context of glaucoma diagnosis and management, the clinical significance of central corneal thickness (CCT) is well acknowledged. It is recommended by both the American Academy of Ophthalmology guidelines and the Canadian consensus recommendations that the CCT measurement be incorporated into the initial evaluation of all patients who have been diagnosed with primary abnormality and individuals who are suspected of having glaucoma.[6] Measuring intraocular pressure (IOP) is crucial for diagnosing and treating optic nerve diseases. Central corneal thickness (CCT) is a factor that impacts the measurement of intraocular pressure (IOP) and should be taken into account when interpreting IOP results. Higher the CCT falsly high the intraocular pressure and vice versa[6,7],So before making the diagnosis of congenital glaucoma it must be remained in mind .Congenital glaucoma is an uncommon medical disorder characterized by elevated intraocular pressure (IOP), alterations in the optic nerve head, and structural abnormalities in the eye, including enlarged corneal and ocular dimensions. Premature neonates have a higher CCT (central corneal thickness) compared to full-term newborns. This thickness gradually diminishes over time.[7-10] There has been a gradual decrease in intraocular pressure (IOP) observed in infants.

The objective of this study was to assess the correlation between central corneal thickness (CCT) and intraocular pressure (IOP) in both preterm and full-term babies. Additionally, the study aimed to compare the differences in IOP and CCT between premature and full-term newborns.

2. MATERIAL AND METHODS

The present prospective observational study was conducted at pediatric ward and NICU Pediatric department at a tertiary care hospital among premature and full-term newborns during the study period of one year. Ethical permission was taken from an institutional ethics committee before commencement of study. Patient's parents /guardian were asked to sign an informed consent form after explaining them about the study.

Through consecutive sampling 50 newborn were selected and divided into two groups i.e. group A and groupB. Group A consist of premature newborn (gestational age<37 weeks) and Group B consist of fullterm newborn (gestational age>.37 week). Cases were selected on the basis of following inclusion and exclusion criteria.

Inclusion criteria- Patients admitted in Pediaric ward and NICU with gestational age < 37 weeks (premature) and gestational age >37 weeks , willing to participate were included in the study.

Exclusion criteria- Patients ocular abnormalities, such as corneal and iris alterations, congenital cataract, retinopathy, glaucomatous corneal and optic disk changes (horizontal corneal diameter .10 mm Hg, C/D .0.4), and familial congenital glaucoma, Patients with a major organ dysfunction or a syndrome or with factors possibly affecting IOP (mechanical ventilation or pulmonary or circulatory complications) were excluded from the study.

The ophthalmologic examination involved using Torch light to rule out any major anomaly and conducting ophthalmoscopy with a binocular indirect ophthalmoscope while the patient's pupils were dilated. All intraocular pressure (IOP) readings were acquired by Tonopen while the newborn was in a supine position and CCT was measured by using ultrasound pachymeter.

Following the administration of 0.5% proparacaine to both eyes, a neonatal Barraquer eyelid speculum was inserted onto the eye. Three consecutive intraocular pressure (IOP) measurements were taken for each eye using a previously calibrated tonometer with a 5% confidence level. The IOP measurement reported for each evaluation was the average of these three measures. Prior to pupil dilation and indirect eye examination of fundus the intraocular pressure was recorded while the infant remained calm and still in order to prevent a Valsalva-like effect. There were no patients who were given sedative medicines or muscle relaxants either before or during the eye examination. The same individual recorded all IOP measurements.

The measurement of central corneal thickness was conducted using a portable device called ultrasonic pachymeter. Three measurements were obtained in each eye, and the average of the measurements was used in the study. The measurements of both eyes of all newborns were conducted by the same operator, consistently between the hours of 3 PM and 5 PM.

The mean values of intraocular pressure (IOP) and central corneal thickness (CCT) were compared using a one-way analysis

of variance (ANOVA) test. The IOP and CCT values of premature and full-term babies were compared using a t-test. The correlation between parameters was tested by linear regression. A multivariate analysis tested the possible effects on IOP of sex, postconceptional age at birth and at measurement, age after birth at measurement, birthweight, and CCT. A P value > 0.05 was considered statistically significant.

3. RESULTS

The study was done on 100 eyes of 50 newborn.Out of 50 cases 29 were premature and 21 were full term newborn (figure 1). Among premature cases 19 were male and 10 were females whereas in among full term mature 14 were male and 7 were females (figure 2).

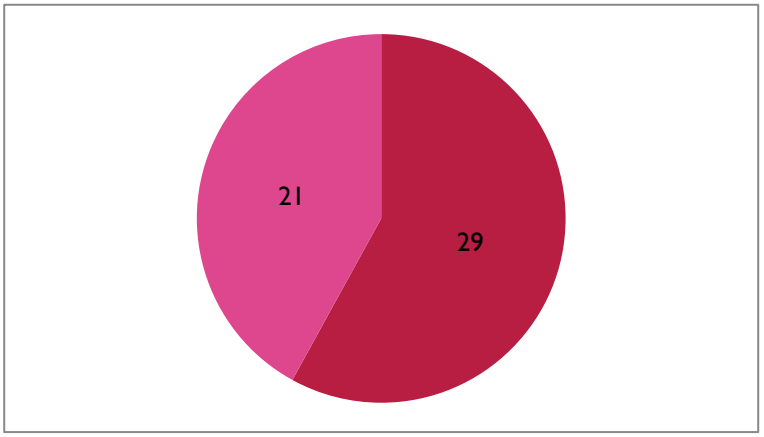

Figure 1 Division of cases

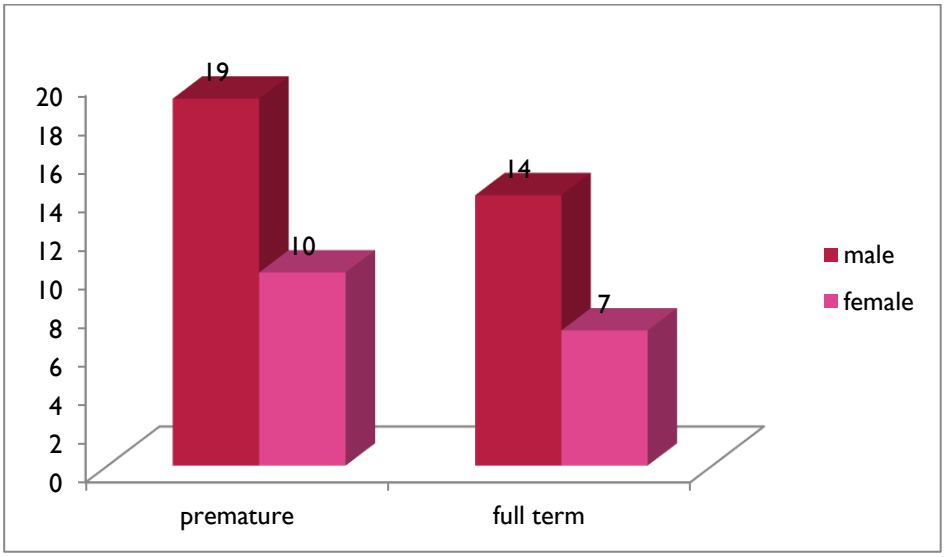

Figure 2 divisions of cases according to gender

The mean age at measurement was 33 ± 2.1 and 38 ± 2 weeks in premature and full term newborns and the comparison was statistically significant (P value ≤0.05) The mean birth-weight was 1578±324 (grams) in pre mature and 2897±456 in full term (grams). The mean intraocular pressure (IOP) was 19.2 ± 3.3 mm Hg in premature newborns and 17.1 ± 2.4 mm Hg in full-term newborns. A t-test analysis showed a significant difference between the two groups (P = 0.001). After adjusting for age after birth, the difference remained statistically significant (P = 0.018). The mean corneal curvature thickness (CCT) was 589 ± 35 mm in premature newborns and 568 ± 25 mm in full-term newborns. This difference was statistically significant, as indicated by the t-test (P = 0.001). Furthermore, even after adjusting for age after birth, the difference remained statistically significant (P < 0.001). These findings are summarized in table 1.The univariate analysis revealed a moderate correlation (r = 0.671) between IOP and CCT. This correlation was further confirmed by the multivariate analysis (P = 0.016). There were no other factors that were associated with IOP. The univariate study revealed a slight correlation between CCT.

Table 1 Demographics CCT and IOP of patients

Variable	Premature newborn	Full-term newborn	P value
Gestational age at birth (week)	33±2.1	38±2	0.001
Birth weight (gram)	1578±324	2897±456	0.001
IOP(mmHg)	19.2±3.3	17.1±2.4	0.001
CCT(um)	589±35	568±25	0.001

4. DISCUSSION

Central corneal thickness (CCT) is a crucial measurement used in the diagnosis and treatment of several eye conditions. An increasing number of children are increasingly being born with a significantly low gestational age. There is a limited amount of data available on the central corneal thickness (CCT) of preterm and full-term children during the neonatal period. Hence the present study was conducted among 50 patients to assess the correlation between central corneal thickness (CCT) and intraocular pressure (IOP) in both preterm and full-term babies. Additionally, the study aimed to compare the differences in IOP and CCT between premature and full-term newborns. In the 1950s, Dolcet [11] and Brockhurst [12] reported average IOPs of 35 mm Hg and 24.5 mm Hg, respectively. These values were significantly higher than what is typically observed in healthy individuals. According to recent research conducted by McKibbin et al [13] and Axer-Siegel et al [14], the average intraocular pressures (IOPs) varied from 15.5 to 16.3 mm Hg.

Measuring intraocular pressure (IOP) is a crucial evaluation for diagnosing and treating neonatal and infantile glaucoma. The measurement of intraocular pressure (IOP) is a crucial indicator for the diagnosis and treatment of ocular hypertension, refractive errors, newborn glaucoma, and other related conditions.[15] Goldmann applanation tonometry has been the established and well accepted method for measuring intraocular pressure for many years[16]. Nevertheless, infants exhibit a lack of cooperation, making it challenging to measure intraocular pressure (IOP) with the Goldmann tonometer. While there are other alternative instruments available, such as the Perkins hand-held applanation tonometer ,Tonopen and pneumatonometers, their usage in newborns and children often necessitates the administration of general anaesthesia. Nevertheless, the inherent characteristics of newborns and young children make it improbable for them to comply during tests, hence posing challenges in accurately measuring their intraocular pressure (IOP). Consequently, significant disparities in IOP measurements arise between subjects who are under anaesthesia and those who are not [17]. Several studies have demonstrated that the measurement outcomes of the Goldmann tonometer and Icare tonometer exhibit strong agreement. Additionally, the Icare tonometer is found to be more convenient for measuring intraocular pressure in newborns and young children. Therefore, the Icare tonometer was chosen for the measurement.[18-20]

The intraocular pressure levels in preterm infants are believed to vary from those in adults and full-term newborns. So far, only a small number of studies have documented intraocular pressure (IOP) in premature newborns.[21] Two earlier investigations conducted in the 1950s indicated a range of typical values between 24.5 mm Hg and 35.0 mm Hg [13,14]. In subsequent clinical studies, the intraocular pressure (IOP) levels varied between 10.1 (±2.0) and 13.3 (±2.9) mm Hg, depending on the age after birth or conception [22].Jethani et al [23]also did a study on comparison of CCT on the basis postgestational age showed a mean thickness of 620.7 ± 88.8 and 574.4 ± 78.3 µ in the <260 days and >260 days age groups respectively which was significant. In our study the IOP value found in premature newborns (19.2 mm Hg) was higher to that recorded by Musarella and Morin [24](18.04 mm Hg). Our data show that some premature newborns without any sign of congenital glaucoma have increased IOP values; Ng et al [21]reported IOP 20.5 mm Hg in 10% of eyes at 26.1 weeks of postconceptional age.A decrease in IOP after birth has been suggested by others ; Ng and colleagues reported a decrease from 16.9 mm Hg at to 14.6 mm Hg at 26.1 weeks and 46.4 weeks of postconceptional age, respectively. In eyes without other glaucomatous alterations, such IOP values cannot be considered pathological.[23,25] Previously Tucker et al found lower IOP values (mean, 10.3 ± 3.5 mm Hg) and suggested considering IOP .18 mm Hg as abnormal.[26]

The CCT value observed in our study for full-term infants (568 mm) was lower than the value reported by Autzen and Bjornstrom[18] (581 mm). In premature newborns with a lower mean gestational age, we found a mean CCT of 599 mm, which is lower than the values reported by Autzen and Bjornstrom [10] (660 mm) and by Kirwan et al [9] (691 mm at 31 weeks).

The CCT (central corneal thickness) decreases after birth in preterm infants and in full-term infants, potentially due to improved regulation of corneal hydration, evaporation, and corneal remodeling (such as an increase in corneal diameter and a decrease in curvature).The value in premature infants may be lower than previously reported due to their increased age after birth.[27] [28]

Our study suggests that the primary determinant of IOP is CCT. While the impact of corneal thickness (CCT) on

measurements taken by the Tono-Pen tonometer is relatively smaller compared to other tonometers, there is still a correlation between CCT and intraocular pressure (IOP) readings detected by the Tono-Pen in youngsters.[29] Ng et al [23] discovered a significant negative correlation between IOP and postconceptional age, as well as some anthropometric measures such as body weight, body length, and head circumference. However, they were unable to provide an explanation for these relationships. The findings of our study indicate a correlation between birth weight and gestational ages, both before and after birth, and central corneal thickness (CCT), which in turn affects the measurement of intraocular pressure (IOP). Previous researchers have discovered a feeble or insignificant connection between intraocular pressure (IOP) and either age or birthweight.[6] There was no observed association between CCT (central corneal thickness) and sex.

The study conducted by Uva et al [15] analysed birth weight and discovered a strong association between CCT and birth weight through multivariate analysis. Gunay et al. [27] also established a correlation between birth weight and CCT. His research on premature children indicated that there was a negative correlation between birth weight and CCT (cerebral cortical thickness). In our study, we observed that birth weight was a significant factor. However, we noticed that premature infants had lower birth weights and thicker corneas. We found significant difference. It is possible that all low birth weight newborns were preterm, as their weights would have increased at a slower rate compared to full-term infants. Nevertheless, the evidence indicates that infants with a lower weight exhibit a thicker cornea.

There are various limitations associated with this study. Initially, it should be noted that the sample size is limited. The study did not consider the impact of some systemic factors on intraocular pressure (IOP). While babies undergoing mechanical breathing, treatment, and experiencing problems that could potentially influence IOP were eliminated, there is a possibility that additional factors may have played a role. The IOP measurement may have been influenced by artefacts. The measurements were conducted using the smallest wire lid speculum while the individuals were under topical anaesthesia. We patiently waited for the baby to become used to the speculum and made sure that it didn't impact the measurement of intraocular pressure . However, the increase in IOP may be attributed to the awake infant's response to the ophthalmic examination. An experiment conducted on anaesthetized youngsters has revealed that the utilisation of an eyelid speculum leads to an average elevation of 4 mm Hg in the intraocular pressure (IOP).[28] This effect may be amplified by the decreased scleral stiffness observed in premature newborns.

5. CONCLUSION

In premature newborns, IOP measurements were slightly greater than in full-term newborns because of an increased CCT. This difference is associated with factors such as post-conceptional age and weight. Lower birth weight appears to be a distinct and separate factor contributing to CCT. Corneal thickness decreases as individuals age and reaches a level comparable to that of full-term newborns after some time. It is important to consider the values when managing corneal issues in both preterm and term infants in the Indian community.

REFERENCES

[1] The STOP-ROP Multicenter Study Group.(2000) Supplemental Therapeutic Oxygen for Prethreshold Retinopathy Of Prematurity (STOP-ROP), a randomized, controlled trial. I: primary outcomes. Pediatrics,105:295-310.

[2] Twa MD.(2018) Intraocular Pressure and Glaucoma. Optom Vis Sci,95(2):83-85.

[3] Kass MA, Heuer DK, Higginbotham EJ, Johnson CA, Keltner JL, Miller JP, Parrish RK, Wilson MR, Gordon MO. (2002)The Ocular Hypertension Treatment Study: a randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. Arch Ophthalmol, 120(6):701-13.

[4] Shiose Y.(1990) Intraocular pressure: new perspectives. Surv Ophthalmol, 34(6):413-35.

[5] Singh K, Shrivastava A. (2009) Intraocular pressure fluctuations: how much do they matter? Curr Opin Ophthalmol, 20(2):84-7.

[6] Sng CC, Ang M, Barton K.(2017) Central corneal thickness in glaucoma. Current opinion in ophthalmology,28(2):120-6.

[7] Phelps DL. Retinopathy of prematurity: clinical trials. (2001).Neoreviews , 2:e167-73.

[8] Ng PC, Kwok AK, Lee CH, et al.(2004) Early pituitary-adrenal responses and retinopathy of prematurity in very low birth weight infants. Pediatr Res,55:114-9.

[9] Autzen T, Bjornstrom L.(1991) Central corneal thickness in premature babies. Acta Ophthalmol (Copenh),69:251-2.

[10] Kirwan C, O'Keefe M, Fitzsimon S. (2005) Central corneal thickness and corneal diameter in premature infants. Acta Ophthalmol Scand ,83:751-3.

[11] Dolcet L.(1952) Tension ocular del recien nacido. Arch Soc Oftal Hispano-am, 12:1057-63.

[12] Brockhurst RJ. (1955).The intraocular pressure of premature infants. Am J Ophthalmol, 39:808-11.

[13] McKibbin M, Cassidy L, Dabbs TR, Verma D, McKibbin M. (1999) Intraocular pressure, pulse amplitude and pulsatile ocular blood flow measurement in premature infants screened for retinopathy of prematurity. Eye, 13:266-7.

[14] Axer-Siegel R, Bourla D, Friling R, et al. (2004) Intraocular pressure variations after diode laser photocoagulation for threshold retinopathy of prematurity. Ophthalmology,111: 1734-8.

[15] Uva MG, Reibaldi M, Longo A, et al.(2011) Intraocular pressure and central corneal thickness in premature and full-term newborns. J AAPOS,15:367-9.

[16] Joshi, Deepti, et al. "A Comparative Study of Central Corneal Thickness and Intra Ocular Pressure in Diabetic and Non-Diabetic Patients in a Tertiary Care Hospital in Kumaon Region, Uttarakhand." Journal of Evolution of Medical and Dental Sciences, vol. 8, no. 49, 9 Dec. 2019, pp. 3715

[17] Yoshikawa K, Murai Y. (1971) The effect of ketamine on intraocular pressure in children. Anesth Analg, 50(2):199.

[18] Pahlitzsch M, Brünner J, Gonnermann J, Maier AB, Torun N, Bertelmann E, et al. (2016) Comparison of ICare and IOPen vs Goldmann applanation tonometry according to international standards 8612 in glaucoma patients. Int J Ophthalmol, 9(11):1624–8.

[19] Jorge J, Fernandes P, Queirós A, Ribeiro P, Garcês C, Gonzalez-Meijome JM. (2010) Comparison of the IOPen and iCare rebound tonometers with the Goldmann tonometer in a normal population. Ophthalmic Physiol Opt, 30(1):108–12.

[20] . Lee KS, Kim SK, Kim EK, Kim TI. (2014) Comparison of intraocular pressure measured by non-contact tonometer, rebound tonometer, tono-pen, and goldmann applanation tonometer. J Korean Ophthalmol Soc, 55(1):47.

[21] Ng PC, Tam BS, Lee CH, et al. (2008)A longitudinal study to establish the normative value and to evaluate perinatal factors affecting intraocular pressure in preterm infants. Invest Ophthalmol Vis Sci.49:87-92

[22] Musarella MA, Morin JD.(1985) Anterior segment and intraocular pressure measurements of the unanesthetized premature infant. Metab Pediatr Syst Ophthalmol,8:53-60

[23] Jethani J, Shah K, Jethani M. Evaluating the change in central corneal thickness in neonates (term and preterm) in Indian population and the factors affecting it. Indian J Ophthalmol. 2015 Jun;63(6):501-3. doi: 10.4103/0301-4738.162601. PMID: 26265640; PMCID: PMC4550982.

[24] Tucker SM, Enzenauer RW, Levin AV, Morin JD, Hellmann J. (1992) Corneal diameter, axial length, and intraocular pressure in premature infants. Ophthalmology,99:1296-300.

[25] Autzen T, Bjornstrom L.(1989) Central corneal thickness in full-term newborns. Acta Ophthalmol (Copenh),67:719

[26] Hikoya A, Sato M, Tsuzuki K, Koide YM, Asaoka R, Hotta Y. (2009) Central corneal thickness in Japanese children. Jpn J Ophthalmol ,53: 7-11.

[27] Gunay M, Celik G, Gunay BO, Dogru M, Gursoy T, Ovali HF.(2014) Central corneal thickness measurements in premature infants. Int J Ophthalmol ,7:496-500.

[28] Mishra, M. and Sahu, N. C. (2021). Air Pollution: A Threat to Biodiversity. International Journal of Environmental Sciences, 7(2), 7-16. https://www.theaspd.com/resources/v7-2-2-2021-December.pdf

[29] Epley KD, Tychsen L, Lueder GT. (2002) The effect of an eyelid speculum on intraocular pressure measurement in children. Am J Ophthalmol,134:926-7.