Assessment of the central corneal thickness and intraocular pressure in premature and full-term newborns

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Purpose: To assess the central corneal thickness (CCT) and intraocular pressure (IOP) in premature and full-term newborns. Materials and Methods: In this study, we evaluated measurements of CCT and IOP in 45 premature and 45 full-term newborns. IOP was determined with topical anesthesia using a Tono-Pen AVIA, applanation tonometer and a wire lid retractor in premature newborns undergoing screening for retinopathy. Full-term newborns were used as a control group. CCT was determined with a portable pachymeter after IOP measurements had been made in both groups. Because there was high correlation of CCT and IOP between right and left eyes, only the right eye data were used for further analyses. Results: The mean gestational age was 31.5 ± 2.7 weeks (ranging 25-35 weeks) and the mean age at measurement after birth was respectively 36.3 ± 0.9 weeks (ranging 33-37 weeks) in premature newborns and 38.2 ± 0.7 weeks (ranging 38-41 weeks) and 42 ± 2.2 weeks (ranging 39-46 weeks) in full-term newborns. The mean IOP was 16.2 ± 2.7 mmHg (ranging 10-22 mmHg) in premature and 16.6 ± 2.3 mmHg (ranging 10-22 mmHg) in full-term newborns. The mean CCT was found 600 ± 50 μm (ranging 515-790 μm) in the premature group and 586 ± 48 μm (ranging 475-730 μm) in the full-term group. Mean CCT was greater in premature newborns than in full-term newborns, but the difference between groups was not statistically significant (P = 0.7). Mean IOP measurement in two groups was found very similar and the difference also was not statistically significant (P = 0.27). There was no correlation between IOP and CCT, gestational age, gestational weight, age at measurement, weight at measurement neither right nor left eye in both groups in multiple regression analysis. Conclusion: We found that premature infants have slightly thicker corneas but no high IOP measurements than full-term newborns. It could be concluded that in premature at the mean gestational age of 36 weeks CCT is not different from that of full-term newborns.

Key words: Corneal central thickness, full-term newborn, intra ocular pressure, premature newborn

Many studies reported that premature newborns have greater central corneal thickness (CCT) than full-term newborns which decreases progressively.¹⁻⁴ A progressive reduction in the intraocular pressure (IOP) of premature infants has been reported, also.¹⁻³ The purpose of this study was to evaluate the CCP and IOP differences in between premature and full-term newborns.

Materials and Methods

Retrospectively, 45 premature newborns with gestational ages ranging from 33 to 37 weeks (mean, 36.3 ± 0.9 weeks) and 45 full-term newborns from 39 to 46 weeks (mean, 42 ± 2.2 weeks) were evaluated. Consecutive premature newborns examined undergoing screening for retinopathy of prematurity and full-term newborns examined undergoing newborn’s eye examination and then their records were used. Newborns with ocular abnormalities or systemic syndromes were excluded from this study. All patients’ family was adequately informed and signed a consent form. The study adhered to the tenets of the Declaration of Helsinki.

The infants lay in a supine position. After topical anesthesia (single drop of 0.5% proparacaine), a wire lid retractor was inserted with care to avoid press on the globe. All measurements were made when newborns were quiet and calm. IOP was measured by tonometer, Tono-Pen (Tono-Pen AVIA applanation tonometer, Reichert, USA) and CCT by portable pachymeter (Optikon Pacline 2000 SpA, major company of research and development, Roma, Italy) centrally. For each eye, three measurements were made and results were averaged. If the IOP results differed by more than 3 mmHg, the measurements was repeated. Then, all infants had ophthalmological examination included ophthalmoscopy by binocular indirect ophthalmoscope in mydriasis. All examinations were made by the same operator, all during the same hours (between 1.30 and 3 PM).

Results of two groups were compared using the two-tailed t-test. The Chi-square test was used for evaluation of the qualitative data such as gender. Descriptive statistical methods (mean, standard deviation), multiple regression analysis, and Pearson Correlation analysis were also used. Because there was high correlation of CCT and IOP between right and left eyes, only the right eye data were used for further analyses. A P < 0.05 was considered statistically significant.

Results

Forty-five premature and 45 full-term newborns were included in this study. The mean gestational age was 31.5 ± 2.7 weeks (ranging 25-35 weeks) and the mean...
Birth weight was 1631.4 ± 537.7 g (ranging 700-2500 g) in premature newborns and 38.2 ± 0.7 weeks (ranging 38-41 weeks) and 2535 ± 888.5 g (ranging 1150-4000 g) in full-term newborns. The mean age at measurement was respectively 36.3 ± 0.9 weeks (ranging 33-37 weeks) and 42 ± 2.2 weeks (ranging 39-46 weeks). The mean weight at measurement was also 2215 ± 485.4 g (ranging 1650-3200) and 3979 ± 772 g (ranging 2300-5500). There was significantly difference between gestational age, birth weight, age at measurement, and weight at measurement of two groups (P < 0.05).

There was no statistically difference between sex of two groups (P > 0.05).

Pearson correlation analysis was used to compare to determine the relationship of two continuous variables. In premature newborns, there was high correlation of IOP and CCT between right and left eyes (r = 0.870; r = 0.978). However, there was no correlation between gestational age and IOP or gestational age and CCT (P = 0.92, r = 0.015; P = 0.43, r = 0.120 for the right eye; P = 0.15, r = 0.216; P = 0.41, r = 0.125 for the left eye). In full-term newborns also the right eye values of IOP and CCT highly correlated with left eye (r = 0.798; r = 0.963). As same as premature newborns, there was no correlation between gestational age and IOP or gestational age and CCT (P = 0.27, r = 0.165; P = 0.36, r = 0.139 for the right eye; P = 0.65, r = 0.071; P = 0.42, r = 0.122 for the left eye). Because there was high correlation of CCT and IOP between right and left eyes, only the right eye data were used for analyses [Tables 2 and 3].

The mean IOP was 16.2 ± 2.7 mmHg (ranging 10-22 mmHg) in premature and 16.6 ± 2.3 (ranging 10-22 mmHg) in full-term newborns. In the premature group, nine eyes (20%) had ≥ 19 mmHg IOP values and eight eyes (17.8%) in full-term newborns without any sign of congenital glaucoma. The mean CCT was found 600 ± 50 μm (ranging 515-790 μm) in the premature group and 586 ± 48 μm (ranging 475-730 μm) in the full-term group. Mean CCT was greater in premature newborns than in full-term newborns, but the difference between groups was not statistically significant (P = 0.07). Mean IOP measurement in two groups was found very similar and the difference also was not statistically significant (P = 0.28).

Multiple regression analysis was constructed with IOP as the dependent variable and gestational age, gestational weight, age and weight at measurement as predictors for right and left eyes in both groups. There was no correlation between these parameters neither right nor left eye in both groups (P > 0.05, r = 277 r square = 0.77; P > 0.05, r = 256 r square = 0.127) [Tables 4-7 and Figure 1].

All newborns’ characteristics and measurement of IOP and CCT are shown in Table 1.

### Discussion

We evaluated the differences IOP between premature and full-term newborns in this study. Uva et al.\(^5\) reported the mean IOP 18.9 mmHg and Musarella et al.\(^6\) 18.04 mmHg in premature newborns. Ricci\(^7\) reported that the mean IOP decreased during the first month of life from 13.25 mmHg to 10.96 mmHg in premature babies. Ng et al.\(^8\) reported a decrease from 16.9 mmHg to 14.6 mmHg at 26.1 weeks and

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**Table 1: Newborns’ characteristics and measurement of IOP and CCT**

| Eyes (n) (OD) | Premature newborns | Full-term newborns | P  |
|--------------|-------------------|-------------------|----|
|              | 45                | 45                | 0.75 |
| Sex          |                   |                   |     |
| Female       | 20                | 23                |     |
| Male         | 25                | 22                |     |
| Gestational age (weeks) |               |                   |     |
| Mean±SD     | 31.5±2.7          | 38.2±0.7          | <0.05 |
| Range       | 25-35             | 38-41             |     |
| Age at measurement (weeks) |             |                   |     |
| Mean±SD     | 36.3±0.9          | 42±2.2            | <0.05 |
| Range       | 33-37             | 39-46             |     |
| Birth weight (g) |               |                   |     |
| Mean±SD     | 1631.4±537.7      | 2535±888.5        | <0.05 |
| Range       | 700-2500          | 1150-4000         |     |
| Weight at measurement (g) |           |                   |     |
| Mean±SD     | 2215±485.4        | 3979±772          | <0.05 |
| Range       | 1650-3200         | 2300-5500         |     |
| IOP (mmHg)  |                   |                   |     |
| Mean±SD     | 16.2±2.7          | 16.6±2.3          | 0.28 |
| Range       | 10-22             | 10-22             |     |
| CCT (μm)    |                   |                   |     |
| Mean±SD     | 600±50            | 586±48            | 0.07 |
| Range       | 515-790           | 475-730           |     |

IOP: Intraocular pressure, CCT: Central corneal thickness, SD: Standard deviation

**Table 2: In premature and full-term newborns, pearson correlation analysis of intraocular pressure results between right and left eyes**

| Correlations | PODIOP | POSIOP |
|--------------|--------|--------|
| PODIOP       |        |        |
| Pearson correlation | 1   | 0.870**|
| Sig. (two-tailed) | 0   | 45     |
| N             | 45     | 45     |
| POSIOP       |        |        |
| Pearson correlation | 0.870** | 1   |
| Sig. (two-tailed) | 0   | 45     |
| N             | 45     | 45     |
| FODIOP       |        |        |
| Pearson correlation | 1   | 0.798**|
| Sig. (two-tailed) | 0   | 45     |
| N             | 45     | 45     |
| FOSIOP       |        |        |
| Pearson correlation | 0.798** | 1   |
| Sig. (two-tailed) | 0   | 45     |
| N             | 45     | 45     |

**Correlation is significant at the 0.01 level (two-tailed).** PODIOP: The mean right eyes intraocular pressure in premature newborns. POSIOP: The mean left eyes intraocular pressure in premature newborns. FODIOP: The mean right eyes intraocular pressure in full-term newborns. FOSIOP: The mean right eyes intraocular pressure in full-term newborns.
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46.4 weeks of postconceptional age, respectively. In our study, the mean IOP was 16.2 ± 2.7 mmHg in premature newborns and 16.6 ± 2.3 mmHg in full-term newborns. There was no significant difference between IOP measurements (P = 0.28).

We also evaluated the differences CCT between premature and full-term newborns in this study. The mean CCT was found to be 691 μm in premature infants and 564 μm in full-term infants in Kirwan et al.[3] study. The mean CCT reported by Uva et al.[1] 599 μm and 576μm in premature and full-term newborns. In our study the mean CCT was 600 μm and 586 μm in premature and full-term newborns. The mean CCT was greater in premature newborns than in full-term newborns, but the difference between groups was not statistically significant (P = 0.07). The difference was not statistical significant due to close ages at measurement.

Kirwan et al.[3] reported that premature infants at 31 weeks’ gestational age have thick corneas and they undergo a dramatic decrease in corneal thickness between this time and term. In another study,10 CCT was measured in 13 premature babies with a gestational age below 33 weeks. No difference was found between the thickness in the first and third postnatal week. At the age of

**Correlation is significant at the 0.01 level (two-tailed). PODCCT: The mean right eyes central corneal thickness in premature newborns, POSCCT: The mean left eyes central corneal thickness in premature newborns, FODCCT: The mean right eyes central corneal thickness in full-term newborns, FOSCCT: The mean left eyes central corneal thickness in full-term newborns**

**Table 3: In premature and full-term newborns, pearson correlation analysis of central corneal thickness results between right and left eyes**

| Correlations | PODCCT | POSCCT |
|--------------|--------|--------|
| Pearson correlation | 1 | 0.978** |
| Sig. (two-tailed) | 0 |  |
| N | 45 | 45 |

| correlations | FODCCT | FOSCCT |
|--------------|--------|--------|
| Pearson correlation | 1 | 0.963** |
| Sig. (two-tailed) | 0 |  |
| N | 45 | 45 |

| **Table 4: Multiple regression analysis for the right eye**

| Model summary** |  |
|-----------------|---|
| Model | R | R square | Adjusted R square | Std. error of the estimate |
| 1 | 0.277* | 0.077 | 0.002 | 2.405 |

**Correlation is significant at the 0.01 level (two-tailed). PODCCT: The mean right eyes central corneal thickness in premature newborns, POSCCT: The mean left eyes central corneal thickness in premature newborns, FODCCT: The mean right eyes central corneal thickness in full-term newborns, FOSCCT: The mean left eyes central corneal thickness in full-term newborns**

**Table 5: ANOVA results for the right eye**

| ANOVA** |  |
|---------|---|
| Model | Sum of squares | df | Mean square | F | Sig. |
| 1 | Regression | 29,741 | 5 | 5,948 | 1,029 | 0,409* |
| Residual | 358,495 | 62 | 5,782 |
| Total | 388,235 | 67 |

**Correlation is significant at the 0.01 level (two-tailed). PODCCT: The mean right eyes central corneal thickness in premature newborns, POSCCT: The mean left eyes central corneal thickness in premature newborns, FODCCT: The mean right eyes central corneal thickness in full-term newborns, FOSCCT: The mean left eyes central corneal thickness in full-term newborns**

**Table 6: Multiple regression analysis for the left eye**

| Model summary** |  |
|-----------------|---|
| Model | R | R square | Adjusted R square | Std. error of the estimate |
| 1 | 0.356* | 0.127 | 0.057 | 2.179 |

**Correlation is significant at the 0.01 level (two-tailed). PODCCT: The mean right eyes central corneal thickness in premature newborns, POSCCT: The mean left eyes central corneal thickness in premature newborns, FODCCT: The mean right eyes central corneal thickness in full-term newborns, FOSCCT: The mean left eyes central corneal thickness in full-term newborns**

**Table 7: ANOVA results for the left eye**

| ANOVA** |  |
|---------|---|
| Model | Sum of squares | df | Mean square | F | Sig. |
| 1 | Regression | 42,835 | 5 | 8,567 | 1,804 | 0.125* |
| Residual | 294,386 | 62 | 4,748 |
| Total | 337,221 | 67 |

**Correlation is significant at the 0.01 level (two-tailed). PODCCT: The mean right eyes central corneal thickness in premature newborns, POSCCT: The mean left eyes central corneal thickness in premature newborns, FODCCT: The mean right eyes central corneal thickness in full-term newborns, FOSCCT: The mean left eyes central corneal thickness in full-term newborns**

Figure 1: Matrix scatter/dot graphy. In matrix scatter/dot graphy, there was no correlation between IOP and CCT, gestational age, gestational weight, age at measurement, *Dependent variable: Right intraocular pressure
3 months the thickness had decreased significantly to the same level previously reported in full-term newborns. One limitation of our study is that changes in IOP and CCT were not compared between same newborns. If initial measurements were recorded at a mean gestational age of 31 weeks and at intervals until term in same newborns, a progressive decline of CCT could be showed.

The Tono-Pen is preferred in pediatric patients and it seems to be less affected by the corneal thickness. In our study the mean IOP measurement by Tono-Pen in two groups was found very similar. Since very similar values of CCT were in two groups it is better to not conclude that Tono-Pen is less affected by corneal thickness; also, no comparison was made with other instruments, so it cannot be stated that is less affected in this study.

In Uva et al.’s study multivariate analysis showed that IOP increased with increasing CCT (P = 0.025) and that CCT declined with increasing birth weight (P = 0.026). In our study there was no correlation between IOP and CCT, gestational age, gestational weight, age at measurement, weight at measurement neither right nor left eye in both groups.

In conclusion, we found that premature infants have slightly thicker corneas but no high IOP measurement than full-term newborns. Our study reports that there was no correlation between IOP and CCT, gestational age and weight, age and weight at measurement neither right nor left eye in both groups. Since several studies showed that CCT is greater in premature newborns and it decreases with age, it could be concluded that in premature at the mean gestational age of 36 weeks CCT is not different from that of full-term newborn.

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Cite this article as: Muslubas IS, Oral AA, Cabi C, Caliskan S. Assessment of the central corneal thickness and intraocular pressure in premature and full-term newborns. Indian J Ophthalmol 2014;62:561-4.

Source of Support: Nil. Conflict of Interest: None declared.