Original Research Article

Keratometry using hand-held and automated keratometers with and without speculum in Indian pediatric cataract – A comparative study

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ABSTRACT

Objectives: To study the keratometry of Indian pediatric eyes, the effect of speculum on keratometry reading, the concordance of hand held and automated keratometry and the effect of unilateral and bilateral cataract on keratometry and IOL power calculation.

Methodology: This was conducted as a cross-sectional observational study on 101 eyes of children in the age range of 41 post-conceptional weeks to 144 months. All cooperative patients were subject to automated keratometry followed by keratometry using hand held keratometer with and without speculum.

Results: Hand held keratometer with and without speculum documented significantly increased average K as well as astigmatism and decreased calculated IOL power when compared to automated keratometry (p<0.01). No significant difference in K readings was observed between unilateral and bilateral cataracts and among males and females (p>0.05). As the age increased, astigmatism increased significantly (R^2=0.07; p=0.007) whereas no such correlation was observed for keratometry (p>0.05).

Conclusion: Hand held keratometry offers the convenience of obtaining accurate keratometry, astigmatism and IOL power measurements in children.

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1. Introduction

Keratometry is used for measurement of corneal curvature of the anterior corneal surface which is essential for early detection and diagnosis of corneal pathology.[1] It is also an integral part of intraocular power calculation. Cornea is attributed the maximum refractive power owing mainly to its refractive index and partly to its radius of curvature.[2]

Keratometry change in pediatric patients is in the form of a steep decline with age in the initial 3 years of life after which it stabilizes to a certain extent. The measurement of corneal curvature is difficult in very young children specially below 2 years of age, hence hand held keratometry is used under anaesthesia to measure the corneal curvature.[3]

In cases of small palpebral aperture, insufficient exposure necessitates the use of speculum, which itself might induce an error by distorting the globe. This added error in keratometry reading can lead to a significant change in Intraocular lens power calculation in the range of 0.8-1.3 D which eventually leads to unwanted postoperative refractive error.[4] Manual keratometry requires a skilled operator and is slower than automated keratometry[5] which can be a problem with frail or unco-operative patients. A portable hand-held automated keratometer offers further advantages for use in these difficult patient groups, such as bed-bound or anaesthetised patients. The keratometry data available on Indian pediatric eyes is limited with very small sample sizes. In this study, we set to find the keratometry of Indian pediatric eyes, the effect of speculum on keratometry reading, the concordance of hand held and automated

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keratometry and the effect of unilateral and bilateral cataract on keratometry.

2. Materials and Methods

The study was conducted as an observational on children within the age group of 41 postconceptional weeks to 144 months, with unilateral congenital and developmental cataract, bilateral congenital and developmental cataract, normal fellow eyes of unilateral cataract and traumatic cataract were included in the study. Children with glaucoma, complicated cataract, persistent fetal vasculature, microphthalmos, traumatic cataract, subluxated lens, syndromic cataract, lasered retinopathy of prematurity cataract, pseudophakic eyes, iridofundal coloboma, microcornea, and spherophakia were excluded from the study.

After obtaining ethical clearance from institute's ethical committee, written consent was obtained from parents of the children fulfilling inclusion and exclusion criteria. Details regarding socio-demographic variables was obtained and entered in pretested semi-structured questionnaire. All the patients were then subjected to detailed visual assessment and cooperative patients were subjected to automated keratometry using the Nidek ARK-510A.

Examination under anesthesia was done for measuring axial length using Echorule Pro Applanation A scan Biometer, Keratometry using the Nidek handy Ref K Hand held Keratometer with and without speculum, of increasing sizes. Immediately after the child was intubated, keratometry was done holding the eyelids gently upwards with fingers exerting least possible compression on eyeball. This was followed by a repeat keratometry done after inserting an appropriate size speculum. Intraocular lens power was calculated using SRKII formula. All investigations were done by the same individual. The children enrolled in the study were treated as per the standard protocol.

2.1. Statistical analysis

Data was compiled using MS Excel and analyzed using IBM SPSS software version. Numerical data was expressed as mean and standard deviation and t- test was used for the analysis of the data collected. P value less than 0.05 was considered statistically significant.

3. Results

In our study, a total of 328 eyes of 164 children were screened. Among them, in 101 eyes (51 children), keratometry was measured with and without speculum with the hand held keratometer and was compared to automated keratometry. Mean age of 51 infants compliant to keratometry was 74.86±39.5 months. Out of 51 children, 39 (76.5%) were boys whereas 12 (23.5%) were girls. 52

(51.5%) and 49 (48.5%) right and left eyes respectively were screened. Cataract was observed in 62 (61.4%) eyes whereas 17 (16.8%) eyes had other findings such as aphakia, pseudophakia, subluxated lens etc. and 22 (21.8%) eyes had a clear lens. Mean axial length in 101 eyes was 22.5±2.12.

Table 1 reveals that the use of speculum significantly increased mean steep K, average K as well as astigmatism and subsequently reduced the calculated IOL power when compared to automated keratometry ($p<0.01$). When readings of hand held keratometer without speculum with that of automated keratometry was compared, it was observed that mean steep K, average K and astigmatism was significantly higher using hand held keratometer as compared to automated keratometry ($p<0.05$), thus giving lower calculated IOL power.

The present study observed no statistically significant difference in mean keratometry and IOL power in hand held keratometry with and without speculum ($p>0.05$).

Our study documented no significant difference in mean keratometry, astigmatism as well as IOL power in cases with unilateral and bilateral cataract using automated keratometer, or hand held keratometer either with or without speculum ($p>0.05$).

Table 4 reveals that as the age increased, astigmatism increased significantly ($R^2= 0.07$; $p= 0.007$) whereas no such correlation was observed for keratometry ($p>0.05$). (Figure 1)
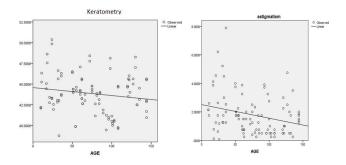

Fig. 1: Correlation of keratometry and astigmatism with age

Our study documented no statistically significant difference in keratometry and astigmatism among male and females ($p>0.05$).

4. Discussions

Mittelviefhaus et al [6] evaluated errors in keratometry in infants and concluded that lack of fixation in children who have keratometry under general anesthesia leads to inaccurate readings. They suggested that deviation from the required postoperative refraction of up to 6.0 D is expected in individual cases if IOLs are implanted. They concluded that to improve the accuracy, multiple keratometric measurements should be taken. [6] Handheld keratometry offers the convenience of obtaining K measurements in

Table 1: Comparison between automated, with speculum and without speculum keratometry findings

	Automated keratometry	With speculum	Mean difference	P value
K1	42.9±2.3	43.1±2.7	-0.16±2.0	0.44
K2	44.7±2.6	45.6±3.0	-0.88±1.9	0.001
Average K	43.8±2.3	44.4±2.7	-0.52±1.8	0.004
Astigmatism	1.8±1.4	2.5±1.6	-0.72±1.4	0.001
IOL power	23.1±5.1	22.7±5.5	0.47±1.6	0.001
	Automated keratometry	Without speculum	Mean difference	P value
K1	42.9±2.3	43.2±2.6	-0.2±1.9	0.27
K2	44.7±2.6	45.4±2.99	-0.7±1.8	0.001
Average K	43.8±2.3	44.3±2.7	-0.4±1.7	0.01
Astigmatism	1.8±1.4	2.3±1.8	-0.5±1.5	0.002
IOL power	23.1±5.1	22.7±5.3	0.4±1.5	0.01
	With speculum	Without speculum	Mean difference	P value
K1	43.1±2.7	43.2±2.6	-0.04±1.5	0.76
K2	45.6±3.0	45.4±2.99	0.19±1.4	0.17
Average K	44.4±2.7	44.3±2.7	0.07±1.2	0.53
Astigmatism	2.5±1.6	2.3±1.8	0.24±1.6	0.14
IOL power	22.7±5.5	22.7±5.3	-0.07±1.1	0.53

Table 2: Effect of unilateral and bilateral cataract on keratometry

		Unilateral cataract	Bilateral cataract	Mean difference	P value
	Automated	42.8±1.7	43.7±2.4	-0.91±0.67	0.18
K1	With speculum	42.6±2.3	43.8±2.4	-1.2±0.75	0.12
	Without speculum	43.3±2.01	43.9±2.3	-0.64±0.68	0.35
	Automated	44.7±1.9	45.4±2.3	0.64±0.68	0.95
K2	With speculum	45.7±3.0	46.2±2.4	-0.4±0.9	0.62
	Without speculum	45.5±2.3	45.9±2.3	-0.38±0.73	0.61
	Automated	43.8±1.7	44.5±2.2	-0.78±0.64	0.23
Average K	With speculum	44.2±2.4	44.9±2.4	-0.8±0.8	0.29
	Without speculum	44.4±1.9	44.9±2.2	-0.5±0.7	0.5
	Automated	1.9±1.4	1.7±1.3	0.3±0.4	0.53
Astigmatism	With speculum	3.2±2.2	2.4±0.9	0.8±0.5	1.5
	Without speculum	2.3±1.8	2±1.2	0.26±0.5	0.55
	Automated	23.6±4.2	23.1±5.9	0.4±1.7	0.79
IOL power	With speculum	23.2±4.7	22.7±6.6	0.5±1.8	0.26
	Without speculum	22.9±3.6	22.8±6.4	0.2±1.2	0.91

Table 3: Comparison of keratometry findings among cataractous and non- cataractous eyes

	WNL	Cataract	P value
K1	43.5±2.3	42.1±2.1	0.01
K2	44.9±3.1	43.9±2.3	0.01
Average K	44.3±2.6	43±2.1	0.01
Astigmatism	1.5±1.3	1.9±1.4	0.43
IOL power	24.5±3.0	21.8±5.3	0.02

Table 4: Correlation of keratometry and astigmatism with age

	R	R2	Adjusted R^2	SE	ANOVA	P value
Mean K	.160	.026	.016	2.348	2.615	.109
Astigmatism	.268	.072	.063	1.364	7.668	.007

Table 5: Comparison of keratometry and astigmatism among male and females

	Male	Female	Mean difference	P value
Average K	43.7±2.2	44.7±2.7	-0.8±0.6	0.15
Astigmatism	1.8±1.5	1.8±1.3	0.02±0.3	0.95

children under anesthesia. However, data regarding use of hand held keratometer and effect of speculum in keratometric reading in children is scarce. The portability as well as ease of use of hand held keratometer can be utilised for screening of young children.[7]

In our study, mean keratometric readings using hand held keratometer with or without speculum was significantly higher as compared to automated keratometer, and IOL power was estimated to be significantly lower using hand held keratometry as compared to automated keratometry. Use of speculum did not affect keratometry, astigmatism and IOL power when we compared hand held keratometry findings with and without speculum (p>0.05). The findings of our study were contrasting to findings of previous studies conducted by Jarvis et al[8] and Kaushik et al[7] in which the authors documented no statistically significant difference in readings of hand held and automated keratometry.

While observing keratometry, astigmatism and IOL power in cases with unilateral as well as bilateral cataract, we observed no statistically significant difference using automated as well as hand held keratometry (p>0.05). These findings were concordant with the findings of Trivedi et al[9] where, the authors documented no significant difference in mean keratometry and astigmatism in cases with unilateral as well as bilateral cataract. Similarly, Asbell and colleagues in their study noted no significant difference between cataractous eyes and eyes without cataract.[10]

In our study, though, K value did not show linear relationship with age but astigmatism significantly increased with age. However, in the study by Trivedi et al,[8] Age and axial length demonstrated a significant linear relationship with K values. Isenberg et al[11] reported a mean K value of 48.5 D at birth, 44 D at 3 months, and 43 D at 6 months.

In this study, no statistically significant difference in keratometry and astigmatism among males and females was observed (p>0.05). Trivedi et al[9] also documented no statistically significant difference in keratometry readings between males and females in different age strata.

5. Conclusion

Hand held keratometry is a convenient method of obtaining accurate keratometry, astigmatism and IOL power measurements in children. Multiple keratometric readings and adequate calibration is necessary for effective and reproducible measurements.

6. Source of Funding

7. Conflict of Interest

The authors declare no conflict of interest.

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