

Biometric Analysis of Cataract Surgery on Adult Candidates in Shanghai, China

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ABSTRACT

Objective: To describe the variation in ocular biometry and investigate the relationship among the parameters of the cataract surgery of adult candidates in Zhongshan Hospital, Fudan University, Shanghai, China.

Methods: This was a cross-sectional study that included 1975 cataract patients (1975 eyes) aged from 18 to 95 years old. Axial length (AL), corneal curvature, anterior chamber depth (ACD) and horizontal corneal diameter (white-to-white [WTW] distance) were optically measured by partial coherence interferometry (IOL Master). Spearman rank correlation coefficients were used to evaluate bivariate correlations.

Results: The average AL and the mean corneal curvature were 24.86 ± 2.72 mm and 44.13 ± 1.58 D, respectively. The mean ACD and WTW were 3.11 ± 0.50 mm and 11.83 ± 0.42 mm, respectively. The mean corneal curvature was negatively correlated with AL, especially in the range of AL from 22 mm to 25 mm, while ACD and WTW were positively correlated with AL. However, the correlation coefficient between AL and WTW was relatively low.

Conclusions: Slight corneal astigmatism, especially against-the-rule (ATR) astigmatism, was common in cataract patients. Corneal curvature seemed to be relatively flat to compensate for the long axial length achieving the emmetropic state in limited range. Corneal expansion was limited with the increasing of axial length.

Keywords: Anterior chamber depth, axial length, cataract, corneal astigmatism, corneal curvature, horizontal corneal diameter

BioAnálisis Biométrico de Candidatos a Cirugía de Cataratas de Adultos en Shanghai, China

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RESUMEN

Objetivo: Describir la variación en la biometría ocular e investigar la relación entre los parámetros de los candidatos de cirugía de cataratas de adultos en el Hospital Zhongshan de la Universidad de Fudan, Shanghai, China.

Métodos: Se trató de un estudio transversal que incluyó 1975 pacientes de catarata (1975 ojos) en edades de 18 a 95 años. La longitud axial (LA), la curvatura corneal, profundidad de la cámara anterior (PCA), y el diámetro corneal horizontal (distancia blanco-blanco[B-B]), fueron medidos ópticamente mediante interferometría de coherencia parcial (IOL Master). Para evaluar las correlaciones bivariadas, se utilizaron coeficientes de correlación de Spearman.

Resultados: El promedio de LA y la curvatura corneal media fueron 24.86 ± 2.72 mm y 44.13 ± 1.58 D, respectivamente. La PCA y B-B fueron 3.11 ± 0.50 mm y 11.83 ± 0.42 mm, respectivamente. La curvatura corneal media se correlacionó negativamente con LA, especialmente en

el rango de LA de 22 mm a 25 mm, mientras que PCA y B-B se correlacionaron positivamente con LA. Sin embargo, el coeficiente de correlación entre LA y B-B fue relativamente bajo.

Conclusiones: *El astigmatismo corneal leve, especialmente el astigmatismo inverso o contra la regla (ACR), fue común en pacientes con cataratas. Curvatura corneal parecía estar relativamente plana para compensar la longitud de un largo axial que alcance un estado emélope en un rango limitado. La expansión córnea se limitó con el aumento de la longitud axial.*

Palabras claves: Astigmatismo corneal, profundidad de cámara anterior, longitud axial, catarata, curvatura corneal, diámetro corneal horizontal

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INTRODUCTION

With the development of techniques and instruments in cataract surgery, it has gradually become a refractive procedure. Besides, patients expect better vision quality after surgery. The optical parameters of the eyeball are especially important for cataract surgery candidates. They are essential in calculating the intraocular lens (IOL) power and directly affect the visual outcome after cataract surgery.

Most studies on ocular biometric parameters were focussed on children (1, 2) and selected groups, such as university students (3, 4) and Marfan syndrome (5). For cataract patients, most studies were about corneal astigmatism (6–9) and paediatric patients with cataracts (10, 11). What is the relation among optical parameters of cataract candidates? Even though there are reports in the literature on ocular biometric parameters (12–17), there are only few reports on the Chinese cataract population (7, 18, 19). In this study, we attempted to investigate the biometric characteristics and the relation among the parameters of Chinese cataract surgery candidates.

SUBJECTS AND METHODS

The datasets of cataract surgery candidates from March 2011 to September 2013, was acquired from the Zhongshan Hospital, Fudan University, Shanghai, China. Ethical approval for this study was obtained from the Ethics Committee of the Hospital. The eligibility criteria were cataract surgery candidates 18 years old or older, non-contact lens wearer, no corneal diseases or ocular disease which affected the measurements by partial coherence interferometry (IOLMaster). These ocular included retinal detachment and vitreous haemorrhage. Besides, the candidates were those without a history of ocular trauma or ophthalmologic operation.

Axial length (AL), corneal curvature, anterior chamber depth (ACD), and horizontal corneal diameter (white-to-white (WTW) distance) were optically measured by partial coherence interferometry (IOLMaster). The data for right eyes only were presented, apart from the asymmetry analyses.

In order to identify the pattern of astigmatism, negative cylinder axes of corneal astigmatism were classified as with-the-rule (WTR, 0° to 30° and 151° to 180°), against-the-rule (ATR, 61° to 120°) and oblique [31° to 60° and 121° to 150°] (13).

Descriptive statistics (the mean and SD; median, range and percentiles) of optical parameters measurements were computed, together with 95% confidence interval. Bivariate correlations were evaluated using the Spearman rank correlation coefficient. All statistical analyses were two-sided with $p < 0.05$ defined as statistically significant. Statistical data were analysed by SPSS software (version 16.0, SPSS, Inc).

RESULTS

This study included 1975 data sets of cataract adult patients' right eyes. Demographics and ocular biometry of these patients were shown in Table 1.

Table 2 shows the patients' corneal astigmatism distribution. As shown in Figure 1 and Table 2, most cataract patients had about 1.00 D corneal astigmatism and against-the-rule (ATR) corneal astigmatism was more common in the cataract surgery adult candidates. Males were more susceptible to ATR astigmatism than female.

The mean corneal curvature (Km) was negatively correlated with the axial length ($p = -0.301$) and the correlation was highly statistically significant ($p = 0.000$). The anterior chamber depth (ACD) and horizontal corneal diameter (white-to-white (WTW) distance) were positively correlated with the axial length ($\rho_{ACD} = 0.589$, $\rho_{WTW} = 0.211$). Besides, the correlations were highly

Table 1: Patients' demographics and ocular biometry

Gender	n	Age (y)	K1(D)	K2(D)	AL(mm)	ACD(mm)	WTW(mm)
Male	857	72.15 ± 11.53	43.20 ± 1.54	44.22 ± 1.56	25.07 ± 2.62	3.18 ± 0.49	11.95 ± 0.42
	43.39%	18~95	33.37~48.21	35.09~49.55	19.22~37.43	1.90~4.75	10.16~13.67
Female	1118	71.17 ± 10.46	43.89 ± 1.59	44.99 ± 1.61	24.70 ± 2.79	3.06 ± 0.50	11.74 ± 0.40
	56.61%	18~93	35.67~49.07	37.01~50.31	20.03~36.63	1.85~5.14	10.44~13.32
Total	1975	71.60 ± 10.95	43.60 ± 1.60	44.66 ± 1.64	24.86 ± 2.72	3.11 ± 0.50	11.83 ± 0.42
		18~95	33.37~49.07	35.09~50.31	19.22~37.43	1.85~5.14	10.16~13.67

n = number, K1 = flat keratometry, K2 = steep keratometry, Data are expressed as the mean ± SD and with the range. AL: axial length; ACD: anterior chamber depth; WTW: white-to-white

Table 2: Patients' corneal astigmatism

Gender	n	Age (y)	Km (D)	Corneal Astigmatism (D)	WTR	ATR	Oblique
Male	857	72.15 ± 11.53	43.71 ± 1.51	1.01 ± 0.71	250	432	175
	43.39%	18 ~ 95	34.23 ~ 48.42	0.05 ~ 6.12	29.17%	50.41%	20.42%
Female	1118	71.17 ± 10.46	44.44 ± 1.56	1.10 ± 0.73	370	536	212
	56.61%	18 ~ 93	36.34 ~ 49.37	0.07 ~ 4.66	33.09%	47.94%	18.96%
Total	1975	71.60 ± 10.95	44.13 ± 1.58	1.06 ± 0.72	620	968	387
		18 ~ 95	34.23 ~ 49.37	0.05 ~ 6.12	31.39%	49.01%	19.59%

n = number, Km = (K1 + K2)/2, K1 = flat keratometry, K2 = steep keratometry, Data are expressed as the mean ± SD and with the range. WTR: with-the-rule; ATR: against-the-rule

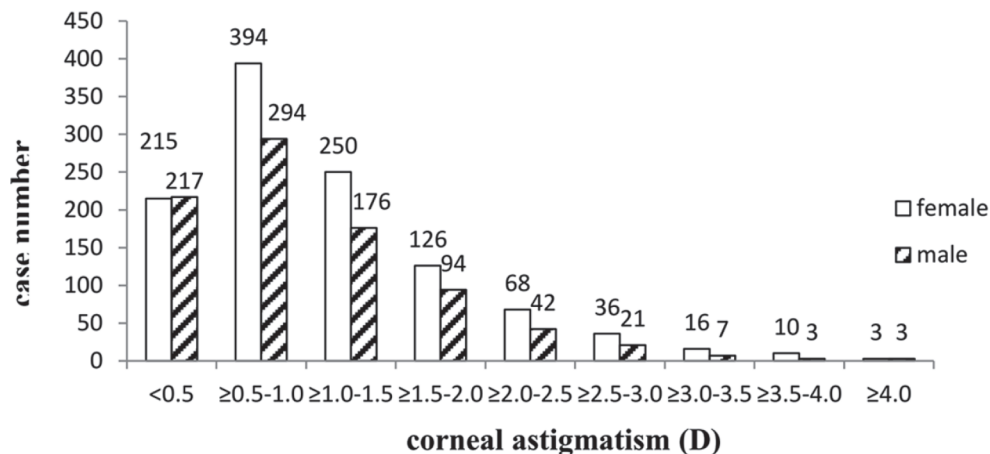


Fig. 1: The number of female and male patients with corneal astigmatism distribution in 0.5 D steps in the entire sample (1975 eyes)

statistically significant ($p = 0.000$). The scatter diagram of the relation of AL and Km is shown in Fig. 2.

The distribution of the spots was close to the line in the range of AL from 22 mm to 25 mm. However, the spots were chaotic out of that range. Furthermore, we analysed the datasets of the range from 22 mm to 25 mm and found that the negative correlation between them increased ($p = -0.438, p = 0.000$).

DISCUSSION

In this study, we retrospectively analysed adult patient cataract datasets of ocular biometry. Most cataract candidates' corneal astigmatism was 1.00 D. We found that 43.29% astigmatism ≥ 1.00 D and ATR corneal astigmatism (49.01%) was more common. It was more common for men to have ATR astigmatism than women. This result is similar to other studies reported in

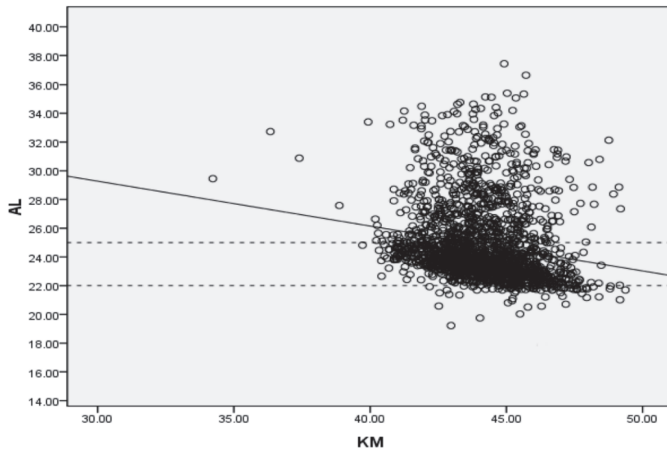


Fig. 2: Showed the scatter diagram of the relationship of the AL and the KM. The two dotted lines showed the interval of AL between 22 mm and 25 mm. The full line was matching the distribution of scatter plots in the interval of AL between 22 mm and 25 mm.

the literature (6, 8, 9, 18). Refractive power of the cornea occupied approximately 2/3 power of the eye, and the corneal astigmatism occupied 90% of the total astigmatism. Astigmatism affected the clarity of the retinal imaging and 1.00 D of astigmatism could introduce about 0.3% in image distortion (20). Cataract surgeons should pay more attention to corneal astigmatism, especially ATR corneal astigmatism.

In this study, the mean corneal curvature (Km) was negatively correlated with the axial length, especially in the range of AL from 22 mm to 25 mm. Corneal curvature deviated more from normal in both longer and shorter eyes. Axial length, corneal curvature and refraction of the lens were three important factors of the ocular refraction state. Tendency of myopia was caused by longer eyes, steeper corneal curvature and greater power of lens. In our study, flatter mean corneal curvature was more possible with the longer axial length in normal population with normal axial length (22 mm to 25 mm). One possible explanation of this phenomenon was that the eye had the tendency of adjusting its structure to achieve the emmetropic state, which may be one of the mechanisms of emmetropization. Elabjer, found that keratometry of the horizontal (K1) and vertical meridian (K2) showed negative correlations with the vitreal body (CV) and AL on both eyes (for K1 $r = -0.64$ for CV $r = -0.54$ for AL; for K2 $r = -0.67$ for CV $r = -0.68$ for AL) of emmetropes (12). Significant correlations were found between AL and flat ($r = -0.54$, $p = 0.001$) and steep

keratometric readings ($r = -0.49$, $p = 0.001$) in normal population (15). However, Hoffmann, found that in eyes with extreme myopia or hyperopia the correlation of AL with corneal radius, ACD and corneal diameter in normal eyes was not proposed (13). Comparing with results of the literatures mentioned above, our study showed that the correlation coefficient of corneal curvature with axial length was relatively low. The discrepancy might partly be due to the differences of population in these studies. Their research mainly focussed on emmetropes or normal population and the axial lengths in their studies were shorter than those in our study.

The ACD was positively correlated with the axial length ($\rho_{ACD} = 0.589$, $p = 0.000$) which was consistent with the results in other studies (12, 21). Besides, the correlation coefficient was a little higher compared with other studies and this might be due to the longer axial length in our study. Furthermore, another reason might be that ACD was affected by the expansion of lens with the development of cataract.

In the current study, the horizontal corneal diameter was positively correlated with the axial length however, the correlation coefficient was very-low ($\rho_{WTW} = 0.211$, $p = 0.000$). Corneal expansion was relatively limited with the increasing of axial length.

In conclusion, we found that Chinese adult cataract candidates of this study had longer axial length than in similar reports from other regions. Slight corneal astigmatism especially ATR astigmatism was common in the cataract patients. Corneal curvature seemed to be relatively flat to compensate the long axial length and further achieving the emmetropic state in the limited range. Besides the above, ACD and WTW were positively correlated with the axial length and the coefficient of ACD was relatively higher. In addition, with the increasing of axial length, the corneal expansion was relatively limited. We investigated the biometric characteristics and the relation among the parameters of cataract surgery candidates which will be significant in this field of research.

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AUTHOR'S NOTE

Fei Yuan is the guarantor of integrity of the entire study; Chen-Li Feng, Yuan-Zhi Yuan and Fei Yuan proposed study concepts; Chen-Li Feng and Fei Yuan proposed study design; Yuan-Zhi Yuan and Xiao-Ping Ma gave

definition of intellectual content; Chen-Li Feng, Xiao-Ping Ma and Yuan-Zhi Yuan did literature research; Chen-Li Feng did clinical studies, data analysis and manuscript preparation; Chen-Li Feng and Chen-Hao Zhang did data acquisition; Chen-Li Feng and Yuan-Zhi Yuan did statistical analysis; Fei Yuan, Xiao-Ping Ma and Yuan-Zhi Yuan edited manuscript and; Fei Yuan reviewed manuscript.

Conflict of interest

Authors declare that there is no conflict of interest.

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