Original Article

Preexisting Corneal Astigmatism in Thai Ageing Population: A Community-Based Study

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Objective: To estimate the prevalence and types of pre-existing regular corneal astigmatism in ageing population of Thailand on a community basis.

Materials and Methods: Data from the study of the "Epidemiology of Age-Related Macular Degeneration among the Elderly Population in Thailand", a cross-sectional observational study done between December 11, 2009 and October 22, 2010, was retrieved by criteria with the age of 50 years or older. The participants who had either eye with aphakic, pseudophakic, or unknown lens status or ocular residual astigmatism (ORA) higher than 5.5 diopters were excluded. The refractive and corneal astigmatic parameters were used to calculate the magnitude and axis of corneal astigmatism and ORA following Alpins method.

Results: There were 3,130 of 10,250 eyes (30.5%) with corneal astigmatism higher than 1 diopter. The pattern of magnitude and proportion of against-the-rule (ATR) corneal astigmatism has been increased by every decade of age. The mean magnitude of corneal astigmatism in the northeastern area was -0.80±0.75 diopters, which was the highest and significantly different from that of the other areas except the central area ($p<0.05$ by Scheffe's test). The mean magnitude of ORA of the central area was the lowest and significantly different from that of the other areas except the capital part ($p<0.05$ by Scheffe's test).

Conclusion: The prevalence of corneal astigmatism in the present community-based study was 30.5%, which was slightly lower than the previous hospital-based reports. The tendency of increasing magnitude and ATR proportion of corneal astigmatism with ageing was comparable to previous studies.

Keywords: Corneal astigmatism, Thai elderly, Community based

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Nowadays, new models and designs of intraocular lens are developed to serve the patient's expectation. Although toric intraocular lens are indicated for corneal astigmatism in cataract patients to achieve good visual outcomes, supporting data on the prevalence and characters of corneal astigmatism represented for the Thai elderly are lacking. Some previous studies have been focused only in referral hospitals reporting 36.6% to 37.8% corneal astigmatism in cataract patients[1,2].

Moreover, there are some published reports on prevalence of corneal astigmatism more than 1 diopter from Spain (34%)[3], United Kingdom (40.4%)[4], China (41.3% to 43.9%)[5,6], and Korea (34.5%)[7].

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Objective

The primary objectives were the prevalence of eyes with corneal astigmatism higher than 1 diopter and the characteristics of corneal astigmatism in the ageing population of Thailand on a community basis. The secondary outcomes were the magnitude and characteristics of ocular residual astigmatism (ORA) as well as differences of corneal astigmatism and ORA among the five main regions of Thailand.

Materials and Methods

The Study design

Based on the original study of the "Epidemiology of Age-Related Macular Degeneration among the

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Elderly Population in Thailand", the present cross-sectional observational study was conducted using a survey unit to collect data from regional-based sample groups.

Participants

Between December 11, 2009 and October 22, 2010, people were recruited from each region of Thailand by a systematic stratified randomization. One province in each region, and a district from each province were randomly selected. People in the selected areas were invited to participate in ophthalmic examination.

Sample size calculation

Based on the prevalence of 1.0 or higher diopter corneal astigmatism from previous studies, the estimated sample size was 373 eyes to detect a prevalence of 41.3% at a precision of 5% and a confidence level of 95%[8,9], independent from the sample size calculation of the original paper.

Eligibility

Participants aged 50 years and older were included. The participants who had either eye with aphakia, pseudophakia, or unknown lens status were excluded. The authors also excluded participants with ORA of higher than 5.5 diopters as high discrepancies between total and corneal astigmatisms could have resulted from data collection error or lens subluxation.

Data collection: Data from each survey unit were extracted as followed:

1. Visual acuity using log MAR chart
2. Refraction and corneal power using Nidek ARK (Auto Ref/Keratometer) 510A
3 Lens status and cataract grading using color pictures from digital slit lamp microscope CSO (Costruzione Strumenti Oftalmici S.r.l.), SL990

Corneal parameters were used to calculate the magnitude and axis of corneal astigmatism. The refractive and corneal astigmatic parameters were used to calculate the magnitude and axis of ORA following Alpins method[10].

Statistical analysis

Mean and standard deviation were used to represent normally distributed variables (refraction, corneal parameters, and ORA). Categorical variables (the prevalence of more than 1 D corneal astigmatism, types of corneal astigmatism, and types of ORA) were described in percentages. Pearson correlation coefficient was used to identify correlation between the age of participants and the magnitude of corneal astigmatism or ORA. Simple linear regression model was used to predict the difference in magnitude of corneal astigmatism related to the age of the participants. One-way analysis of variance and Scheffe's test were used to compare mean magnitude of corneal astigmatism and ORA between each region of Thailand. The p-value less than 0.05 was considered statistically significant. Statistical analyses were performed using IBM SPSS software, version 21.0 (IBM Corp., 2012, Armonk, NY, USA). Incomplete or missing data were shown in percentage and handled by listwise deletion method.

The present study was approved by the Institutional Review Board of Naresuan University (No.1127/60, May 2018).

Table 1. Participant demographics

Characteristic	Male Mean±SD	Female Mean±SD	Total Mean±SD
No. of patients	1,445	3,680	5,125
No. of eyes	2,890	7,360	10,250
Age (year)	62.04±8.09	60.40±7.71	60.86±7.85
Range	50 to 90	50 to 99	50 to 99
K (D)	44.19±2.16	44.90±2.17	44.70±2.22
Flat K	43.83±1.53	44.52±1.53	44.33±1.57
Steep K	44.55±1.52	45.28±1.53	45.07±1.57
Range	36.75 to 50.75	36.25 to 53	36.25 to 53
ΔK	−0.71±0.65	−0.75±0.67	−0.74±0.67
Sphere (D)	0.68±1.89	0.81±1.94	0.77±1.93
Range	−14.5 to 13.5	−22.50 to 8.50	−22.5 to 13.5
Cylinder (D)	−1.09±0.83	−1.05±0.85	−1.06±0.84
Range	−6.75 to 0	−9.25 to 0	−9.25 to 0
ORA (D)	−0.88±0.55	−0.96±0.56	−0.94±0.56
Range	−5.16 to 0	−5.5 to 0	−5.5 to 0

K=keratometry; ORA=ocular residual astigmatism; SD=standard deviation

Results

The study comprised of 7,518 participants from the five regions of Thailand Representative areas, Nonthaburi for capital & suburban area, Phitsanulok for the central, Phayao for the north, Khon Kaen for the northeast, and Chumporn for the south. The authors excluded 1,230 participants for abnormal lens status, 10 participants for extreme ORA, and 1,153 for incomplete data (18.3% of the remaining participants). Ten thousand two hundred fifty eyes from 5,125 participants were included for

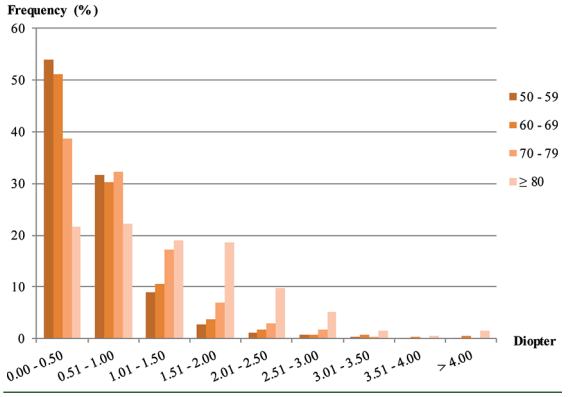

Figure 1. Magnitude of corneal astigmatism.

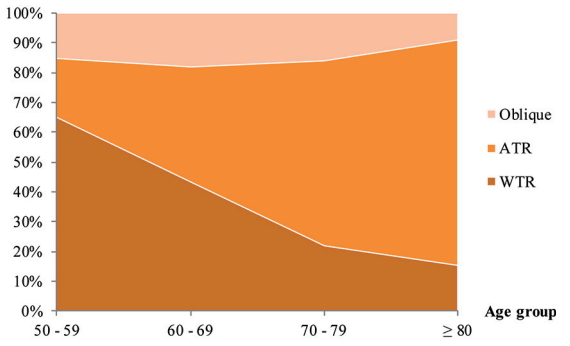

Figure 2. Type of anterior corneal astigmatism.

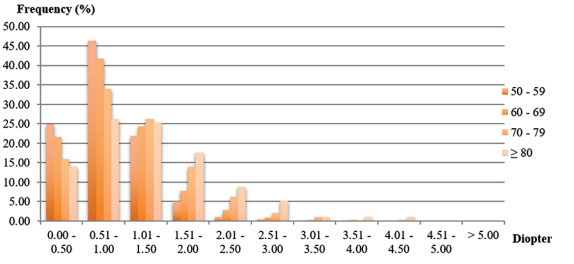

Figure 3. Magnitude of ocular residual astigmatism.

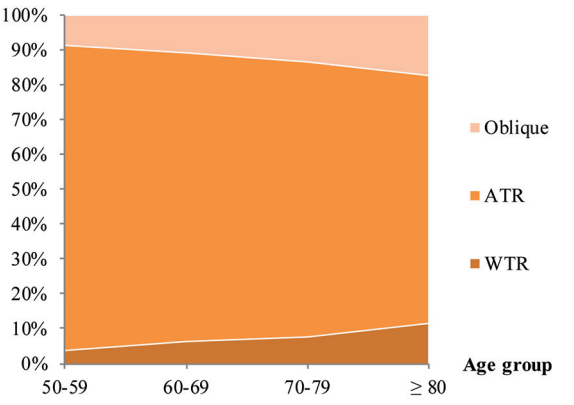

Figure 4. Axis of ocular residual astigmatism.

Table 2. Magnitude of astigmatism from each region

Region	Corneal astigmatism Mean±SD	ORA Mean±SD	n (eye)
Capital	−0.71±0.60	−0.93±0.52	1,328
Central	−0.75±0.71	−0.89±0.57	2,058
North	−0.74±0.64	−0.96±0.57	2,464
Northeast	−0.8±0.75	−0.98±0.60	1,850
South	−0.72±0.61	−0.94±0.54	2,550
Total	−0.74±0.67	−0.94±0.56	10,250

ORA=ocular residual astigmatism; SD=standard deviation

the statistical analysis. The demographic data of the participants is shown in Table 1.

Primary outcome

Three thousand one hundred thirty eyes out of 10,250 eyes (30.5%) had corneal astigmatism of higher than 1 diopter. The magnitude of corneal astigmatism in each age group is shown in Figure 1. The magnitude tended to increase with age (Pearson correlation coefficient; r=0.156, 95% CI 0.137 to 0.175). Simple linear regression model showed that the magnitude of corneal astigmatism increased by 0.0132 diopter per year. The type of corneal astigmatism was more with-the-rule (WTR) in age group 50 to 59 year, and more against-the-rule (ATR) in age group 70 to 79, and 80 year and above, and equivocal in age group 60 to 69 year (43.24% WTR, 38.87% ATR) as shown in Figure 2.

Secondary outcome

The mean magnitude of ORA was 0.94±0.56 D, which tended to increase in higher age groups as depicted in Figure 3 (Pearson correlation coefficient; r=0.196, 95% CI 0.177 to 0.215). The types of ORA were mostly ATR in all age groups. Figure 4 shows the types of ORA in each age group.

Additionally, the mean magnitude of corneal astigmatism of the Northeast sample group was significantly different from that of the other areas except the central area ($p<0.05$ by Scheffe's test). The mean magnitude of ORA of the central area was significantly different from that of the other areas except the capital area ($p<0.05$ by Scheffe's test). Table 2 shows the mean of corneal astigmatism and ORA among the five regions. Table 3 shows

Table 3. Difference of corneal astigmatism between each region

Region	Compare to	Mean Difference	SD	p-value
Capital	Central	0.043	0.023	0.497
	North	0.025	0.023	0.873
	Northeast	0.088	0.024	0.009*
	South	0.014	0.022	0.984
Central	Capital	–0.043	0.023	0.497
	North	–0.179	0.020	0.936
	Northeast	0.045	0.021	0.339
	South	–0.029	0.020	0.700
North	Capital	–0.025	0.023	0.873
	Central	0.179	0.020	0.936
	Northeast	0.063	0.020	0.049*
	South	–0.011	0.019	0.986
Northeast	Capital	–0.088	0.024	0.009*
	Central	–0.045	0.021	0.339
	North	–0.063	0.020	0.049*
	South	–0.074	0.020	0.009*
South	Capital	–0.014	0.022	0.984
	Central	0.029	0.020	0.700
	North	0.011	0.019	0.986
	Northeast	0.074	0.020	0.009*

SD=standard deviation

* The mean difference is considered significant

the difference of the mean magnitude of corneal astigmatism by Scheffe's test.

Discussion

The present study revealed that 30.5% of the nationwide participants had corneal astigmatism of more than 1.0 diopter. Compared to previous studies in Thailand and other regions, the present study reported a lower proportion of corneal astigmatism as the present study recruited participants regardless of visual impairment or cataract grading and was conducted in a community-based setting. The types of astigmatisms that prevailed in each age group were comparable to those in previous studies, in which WTR and ATR astigmatisms are more common in lower and higher age groups, respectively.

ORA is the vectorial difference between corneal astigmatism and manifest cylinder. Having been involved in corneal refractive surgery, ORA has been widely studied in younger people and less studied in ageing population[11,12]. The authors could not exclude keratoconic eyes by using average keratoconic ORA as it would involve a significant proportion of normal eyes, so the authors excluded participants with ORA of higher than 5.5 D (mean keratoconic ORA plus 1 SD[13]) to exclude data collection error. The present study reported 0.94±0.56 D mean ORA with the majority being ATR. However, both magnitude and axis of ORA were found to be consistent with those of previous studies[9-11].

Limitation

The present study did not exclude conditions that might affect corneal astigmatism such as pterygium, irregular astigmatism from corneal ectasia, or patients who had experienced refractive surgery.

The keratometer in the present study could only measure the anterior corneal power, not the posterior corneal power, so the total corneal power that may affect the IOL power selection was unmeasured.

The study did not adjust the age of the participants to that of the whole Thai population. As a result, it may affect the accuracy of parameters that are not specific in each age group (e.g., mean corneal astigmatism, ORA or cylinder of the entire participants).

Conclusion

The prevalence of corneal astigmatism in the present community-based study was slightly lower than previous hospital-based reports. The tendency of increasing magnitude and ATR proportion of corneal astigmatism with ageing was comparable to previous studies.

What is already known on this topic?

For the elderly, the magnitude of astigmatism increases, and the prevalence of ATR astigmatism is related to the increasing age.

What this study adds?

The prevalence of corneal astigmatism in community is less than hospital-based setting. The mean corneal astigmatism and ORA were similar among the five regions of Thailand.

Acknowledgement

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Conflicts of interest

The authors declare no conflict of interest.

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