INTRODUCTION

Early investigations into the distribution of corneal topography patterns in different populations were conducted on healthy individuals to identify the variability of existing corneal patterns. Corneal topography and especially elevation based techniques (i.e. Slit-beam Scanning in Orbscan, Scheimpflug Camera in Pentacam) have been increasingly used for deciding on refractive correction methods and diagnosis of some corneal disorders like keratoconus. Keratoconus is one of the ectatic disorders, which accompanies with progressive protrusion and thinning of the cornea and irregular astigmatism. Although keratoconus is a challenging subject for ophthalmology clinicians yet, its epidemiologic aspects (i.e., prevalence, etiology) are either attractive. Middle-east countries have been zoomed in recently by keratoconus prevalence studies. Considering the importance of corneal topography in keratoconus detection, population-based data from this region could be judged as noticeable evidence in this context. The most common classification of corneal topographic maps is that provided by Rabinowitz et al. Among these patterns, skewed radial axis (SRAX) patterns have showed association with keratoconus. In this study, we determine the distribution of topographic patterns of studied people to see whether there is a background for hypothesized prevalence.
MATERIALS AND METHODS

The Tehran eye study was a cross-sectional study performed in 2002 and the detailed methodology of the study was reported previously. Briefly, random stratified cluster sampling was performed based on populations in different regions of Tehran. In total, 160 clusters were identified, each of which contained 10 households. After randomly determining the first household in each cluster, others were selected in a clockwise direction. All members of the family were familiarized with the objectives of the study and those who were willing to participate were invited to the Noor Eye Clinic for ophthalmologic examination. Of these, 442 individuals from districts in Tehran underwent corneal topography. Exclusion criteria were: History of refractive surgery, cataracts, glaucoma, use of contact lenses, use of ophthalmological drops, Axial maps with no clear central 6 mm zone of cornea and trauma cases. No limits for age or keratometric changes were applied. Axial power maps that did not include the complete central 6 mm of the cornea and cases with clear artefacts were excluded.

Corneal topography

Corneal topography was performed by slit-beam scanning topography with Orbscan II (Bausch and Lomb Surgical, Salt Lake City, USA). This method uses a video-assisted slit lamp diagnostic system and was introduced in the late 1990s. In this study, version 3 of the software included with the instrument was used for modeling. Blinks were not prevented except for immediately before imaging. Imaging was performed using color coded maps based on standard relative style. Steps of 0.5 Diopter (D) were used for the axial power maps. Each color was ± 0.25 D higher and lower than its determined value. Green was used to determine the median axial power. The location, examiner and device were the same for all examinations in order to control for their biases as much as possible. Classification of corneal topography patterns was performed by expert ophthalmologists on the basis of the 10 patterns [Figure 1] described by Rabinowitz et al. Elevation data were calculated based on best fit sphere on 8 mm diameter.

In statistical calculations, generalized estimating equations method was applied to control the relationship between right and left eyes. Then means of studied indices were compared among groups. P < 0.05 was considered as significant in analyses.

This study was approved by the ethics committee of the National Research Center. The participants were informed of the research methodology using comprehensible local language and their verbal consent to participation was obtained.

RESULTS

A total of 6497 individuals were invited to participate in the Tehran Eye Study, 4562 of whom responded (response rate = 70.3%). Of these respondents, 442 (aged >14 years and living in districts 1-4) were selected for corneal imaging. After applying the exclusion criteria, 410 healthy individuals were eligible for corneal topography. Lack of fixation on the central topography target and regular keratometric rings caused 22 individuals to only undergo corneal scanning of one eye. Eleven scans were excluded because of artefacts. Thus, 404 individuals (788 eyes) were studied. Among all participants, 231 (60.8%) were female. Mean age of the participants was 40.9 ± 16.9 years. Table 1 shows more details of the evaluated indices.

Distribution of corneal topography patterns

As can be seen in Figure 2, the symmetric bowtie (SB) (29.0%) and asymmetric bowtie with inferior steepening (IS) (16.7%) patterns were the most common, followed by the round (16.0%), asymmetric bowtie with superior steepening (SS) (10.0%), asymmetric bowtie with SRAX (AB-SRAX) (7.6%), oval (6.6%), IS (4.7%), SB with SRAX (SB-SRAX) (4.7%), irregular (3.3%) and SS (1.4%) patterns. A total of 68.0% of patterns were classified as bowtie and 32.0% as non-bowtie.

The mean age of individuals in the different corneal topography groups was found to be significantly different (P < 0.001). As can be seen in Table 1, the lowest mean age was associated with the SB pattern (35.48 ± 16.19 years) and the highest mean age with the irregular pattern (49.88 ± 18.25 years). The most frequent patterns observed in individuals >50 years were round (41.9%), oval (46.3%) and irregular (57.7%). In general, individuals with a non-bowtie pattern (44.6 ± 16.9) were older than those with a bowtie pattern (39.1 ± 16.6) (P < 0.001). Participants aged ≥30 years had higher mean corneal power (P = 0.036) [Table 1].

Studying the effect of sex on the distribution of patterns revealed a borderline non-significant relationship (P = 0.087).

In comparison with round and SB patterns, corneas with an AB-SRAX pattern had either thinner cornea (P < 0.014) or steeper ones (P < 0.006). As can be seen in Table 1, age categories made no difference in central corneal thickness (P = 0.186). Maximum anterior elevation in 5 mm zone (AE), of AB-SRAX corneas were higher than other patterns (P < 0.010) except for superior steepened and inferior steepened ones. According to age categories, no change was seen in AE (P = 0.116). Maximum posterior elevation in 5 mm zone (PE) showed no difference among different patterns (P = 0.336). Mean PE of people less than 30 years (25 µ) was lower than ones aged ≥ 30 years (29 µ) (P = 0.008).
In general, bowtie patterns (SB/AB) were clearly dominant in the studied population. The bowtie patterns with SRAX were observed among more than 12% of studied corneas. Compared with findings of Rabinowitz et al.,\(^1\) (2%), that is a noticeable prevalence for such rare patterns. Considering the association between SRAX patterns and keratoconus\(^1\) this preserve more notice.

A relationship between age and changes in corneal topography has been reported in a number of different studies.\(^13,14\) As stated in the results of this report, dominant patterns in older individuals were round, oval and irregular. Topuz et al. found a change from the vertical bowtie pattern in individuals younger than 30 to a round pattern in those older than 30.\(^15\) Furthermore, in the present study, individuals with a SB pattern had the lowest mean age (35.5 ± 16.2 years) and older individuals had an irregular pattern (49.9 ± 18.2 years). Differences in the frequency distribution of corneal patterns can to some extent be attributed to age, which has been confirmed by Riley et al.\(^15\) Age related changes in tear film quality could be addressed as a related factor in this context. The slight power change in the older group could be attributable to this.

The effect of sex on the distribution of corneal topography patterns has been the subject of several studies. Data from the present study showed a similar distribution of corneal topography patterns in men and women. Rabinowitz et al.,\(^1\) whose study conformed most closely to the objectives and pattern distributions of the present study, also reported similar distribution patterns in men and women.\(^1\) However, Goto et al. reported differences in men and women as they focused on quantitative indices and astigmatism patterns separately (with-the-rule/against-the-rule).\(^14\) It is possible that the age distribution of the studied individuals was an underlying cause of the differences observed between men and women.

An association between mean power and topography pattern has been indirectly stated in studies of the corneal topography patterns of individuals with keratoconus.\(^16,17\) Some of the studies on keratoconus cases\(^10,11\) have reported that the AB-SRAX pattern is most common in individuals with/suspected of having keratoconus. Our data by revealing higher mean corneal power in the AB-SRAX pattern confirm this. The difference in mean corneal power in individuals with this pattern compared with those with a round or SB pattern is clear.

Elevation data either show specific features for AB-SRAX patterns. Higher maximum elevations at both anterior and posterior surfaces than many other patterns could be interpreted as another evidence for their association with keratoconus.
Respected values were between related findings of other studies on manifest keratoconus groups\textsuperscript{18,19} and keratoconus suspect groups.\textsuperscript{20,21} Especially in these studies, PE has been noticed in determining keratoconus and grading its progress.\textsuperscript{22}

If all bowtie patterns be merged in one category, their dominant frequency against non-bowtie patterns would be apparent. As shown in Table 2, the difference in bowtie/non-bowtie pattern ratio in Asian populations compared with European and American (White ethnicity) populations is clear. Although the findings of Modis \textit{et al}. are geographically related to Europe, their distribution is different from that of common patterns observed in European populations. As a subtype of bowtie patterns, the frequency above than 12\% of patterns with a SRAX in the studied population highlights the need to pay attention to such differences. Ethnic features could be addressed as a possible explanation. That is the point also mentioned by others who find higher prevalence of keratoconus among Asia/middle-east people.\textsuperscript{6,7}

**CONCLUSION**

The distribution of corneal topographic patterns in Iranians seems like other Asian societies on the whole. Patterns with SRAX, which were considered especially in this study, were observed among more than 12\% of cases. This amount of SRAX patterns brings this to mind that maybe keratoconus prevalence is higher in our population. More profound regional studies are needed to ascertain the reliable prevalence rate of keratoconus and its etiologic background.

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