Intraocular pressure with an air-puff tonometer in a young population

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INTRODUCTION

High intraocular pressure (IOP) is considered as one of the most important risk factors of glaucoma.[1] Associations between IOP, age , blood pressure, myopia and central corneal thickness have been reported in previous studies.[2-5]

Most previous studies on IOP distribution have shown its normal range in the middle-aged and the elderly, and few studies have reported IOP in the young population.[6,7] The majority of previous studies showed the IOP measured with the Goldmann tonometer, while recently, non-contact air - puff tonometers have become common in clinical practice.[8]

In this study, we intend to describe the normal range of IOP in an Iranian population using a non-contact air- puff tonometer. Results of this study can be used as a reference for the Middle East population. Since studies on young populations are few on the global level, results of this study can be used too. Also, due to the limited literature on normal population IOP with non-contact air- puff tonometers, results of this study can be considered for developing nomograms as well.

METHODS

Population and Samples

Subjects were selected from the students of Mashhad University of Medical Sciences through stratified cluster sampling by considering all students in each academic department as a stratum. Stratification was then done based the student's entrance year. Finally, we used student ID numbers to perform random sampling proportionate to the number of students in each stratum. Selected students were invited to participate in the study. All interviews and examinations were performed at one site. In the interview, which was done first, we collected demographics as well as information regarding family history of keratoconus, history of allergy, and eye rubbing habits. Exclusion criteria were a history of refractive or other ocular surgery and history of wearing contact lenses.

Examinations

Eye examinations included refraction, slit lamp biomicroscopy, imaging and IOP measurement . Refraction was performed by using an auto refractometer (Topcon RM 8800), and checked by retinoscopy (Heine Beta 200). Imaging study included acquisition with Orbscan II (Bausch &Lomb Inc., Rochester). Slit lamp exams were done after imaging with Orbscan was complete. Finally, IOP was measured, three times for each eye, using Topcon CT-80 noncontact tonometer.

Definitions

Myopia was defined as a spherical equivalent (SE) less than -1.00 Dioptre (D), hyperopia was defined as a SE more than +1.00 D. The diagnosis of keratoconus was made based on the findings of the topographic maps plus the clinical indices.

Statistical analysis

IOP data were summarized into mean and 95% confidence interval (CI). Histograms ,skewness and kurtosis parameters were used to demonstrate the distribution of IOP. We also determined 50th, 95 th, and 99.5 th IOP percentiles. Simple and multiple linear regression methods were used to examine associations of IOP with other parameters.

Ethical issues

The Ethics Committee of Mashhad University of Medical Sciences approved the study proposal. Before enrollment, all participants signed an informed consent after the study purpose and its methodology was explained to them.

RESULTS

Of the 7645 students of Mashhad University of Medical Sciences in 2013, we selected 1280 individuals, and 1073 (83.8%) of them participated in the study. After applying the exclusion criteria, the study was done using data from 1027 people. Mean age of the participants was 26.1 ±2.3 years (range, 20 to 34 years). Due to the high correlation between right and left eye IOP readings (Pearson correlation =0.852), the results from the right eyes were analyzed.

Figure 1 shows the distribution of IOP in subjects which was skewed to the left (negative) with a skewness value of -0.095 and a kurtosis index of 0.322. The 25th, 50th, 95th, and 99.5th percentiles of IOP were 15, 17, 20, and 23 mmHg, respectively. Mean IOP was 16.38 (95% CI: 16.22-16.53) mmHg; 16.14 95% CI: 15.84-16.45) mmHg in men and 16.48 (95% CI: 16.31-16.66) mmHg in women. IOP was significantly higher in women (p=0.043), even after adjusting for age (p=0.041).

Mean IOP had an ascending trend starting from 16.22 mmHg in the 20-22 age group to 16.57 mmHg in the over 28 year age group (Table 1). Linear regression indicated that the age-related increase in IOP was statistically significant (P=0.046),even after adjusting for gender (p=0.044).Table 1 also shows the mean IOP by iris color; there was no significant association between iris color and IOP (p=0.823).

Mean IOP were 15.51 (95% CI: 15.36-16.27) mmHg, 16.46 (95% CI: 16.30-16.63) mmHg, and 15.36 (95% CI: 14.15-16.58) mmHg in emmetropes, myopes and hyperopes repectively. Analysis of variance test using Scheffe's test revealed significant IOP differences between myopic and emmetropic groups (p=0.031).

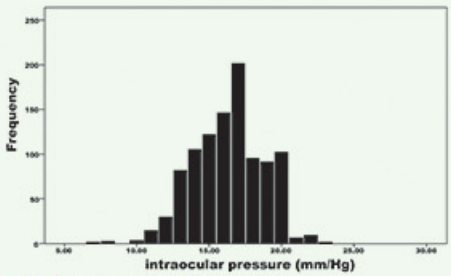

Figure 1. Distribution of intraocular pressure

Table 1. Mean IOP and 95% confidence interval (CI)by age, gender and iris color.

		n	Mean	95%CI Lower band	95%CI Higher band
	Total	1027	16.38	16.22	16.53
Gender	Male	324	16.14	15.84	16.45
	Female	703	16.48	16.31	16.66
Age	20-22	175	16.22	15.84	16.61
	23-25	275	16.08	15.78	16.37
	26-28	239	16.55	16.24	16.86
	>28	338	16.57	16.30	16.85
Iris color	Blue	3	15.33	10.16	20.50
	Light brown	191	16.22	15.85	16.59
	Medium brown	431	16.40	16.16	16.63
	Dark brown	383	16.43	16.18	16.68
	Green	19	16.53	15.47	17.58

There were 26 cases of keratoconus among the subjects of this study. Mean IOP was 13.11 (95% CI: 11.63-14.60) mmHg in keratoconic eyes and 16.64 (95% CI: 16.3-16.6) mmHg in non-keratoconic eyes. T-test showed that IOP was significantly lower in keratoconus eyes (p<0.001).

Figure 2 illustrates the mean IOP in groups of corneal thickness. IOP significantly increased as the corneal thickness increased; IOP was 14.56 mmHg in the under 500 µm thickness group and increased to 17.35 mmHg in those with a cornea thicker than 600 µm.

We used a multiple linear regression model to examine IOP relationships with parameters extracted from Orbscan (Table 2). IOP showed direct relationships with age and central corneal thickness, and inverse associations with corneal diameter, spherical equivalent, and mean keratometry reading. According to the standard coefficients of this model, IOP related most strongly with central corneal thickness followed by spherical equivalent. In the next model, we added keratoconus as a variable (Table 2); all variables showed a relation similar to the previous model except mean keratometry reading. This model showed a lower IOP in keratoconic cases compared to non-keratoconic eyes after adjusting for age, gender and other variables.

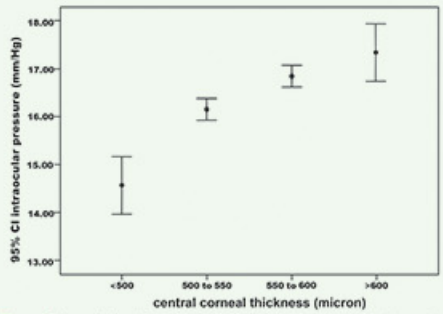

Figure 2. Association between intraocular pressure and central corneal thickness

Table 2. Association between IOP and studied variables based on the multiple linear regression two models.

	Model 1 Coefficients (95%CI)	Model 1 SC	Model 1 p-value	Model 2 (model 1 + Keratoconus) Coefficients (95%CI)	Model 2 SC	Model 2 p-value
WTW (mm)	0.649 (-1.106 -0.192)	-0.102	0.005	-0.48(-0.941-0.019)	-0.076	0.041
PD (mm)	0.061(-0.1-0.221)	0.022	0.458	0.056(-0.103-0.215)	0.021	0.492
ACD (mm)	0.216(-0.391-0.824)	0.024	0.485	0.100(-0.505-0.706)	0.011	0.745
CCT (micron)	0.017(0.013-0.022)	0.256	<0.001	0.015(0.011-0.02)	0.227	<0.001
Age (year)	0.052(0.007-0.097)	0.065	0.023	0.046(0.002-0.091)	0.060	0.042
Gender (male/female)	0.151(-0.181-0.482)	0.028	0.372	0.106(-0.224-0.436)	0.020	0.527
SE (diopter)	-0.15(-0.208-0.093)	-0.155	<0.001	-0.152(-0.209-0.095)	-0.157	<0.001
Mean-keratometry (diopter)	-0.107 (-0.205-0.01)	-0.075	0.031	-0.036(-0.139-0.066)	-0.026	0.487
Keratoconus (yes/no)				-2.115(-3.147-1.083)	-0.132	<0.001

SC: Standardized Coefficients
WTW: White to White
PD: Pupil diameter
ACD: Anterior chamber depth
CCT: Central Corneal thickness
SE: spherical equivalent

CONCLUSIONS

The results of this study demonstrated the IOP distribution in a normal young population using a non-contact method and can be used as a reference for other studies. This study indicated that central corneal thickness and refractive errors (SE) strongly correlated with IOP.

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