To Evaluate a Relationship Between the Intraocular Pressure with Age, Blood Pressure and Central Corneal Thickness in A Tertiary Hospital in Central India: A Cross-Sectional Observational Study

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Abstract:

Glaucoma commonly known as the Thief of sight. It is a group of eye disorders that lead to progressive damage to the optic nerve. The measurement of central corneal thickness (CCT) and intraocular pressure (IOP) is essential in the clinical assessment of glaucoma. Recognizing the significance of CCT and IOP in diagnosis, several researchers have investigated their variation among and within various populations.

Objective: The objective of this study is to establish a relationship between the intraocular pressure with age, blood pressure and central corneal thickness.

Materials and Methods: Cross sectional observational study was performed enrolling all patients giving consent for the study, between the of age between ≥40 and ≤80 years of either gender, and with or without any grade of senile cataract. Patients with or without refractive error (WITH MILD GRADE MYOPIA ONLY) and anterior chamber Van Herrick grading of >II were also included. Five hundred (500) patients were included for this study coming to Index Medical College and Hospital. Out of 500 patients 53.2% belong to the age group of 40-59 years (53.2%). In age group 60-80 years, there were 46.8% patients, where 257 (51.4%) were male and 243 (48.6) were female. values were calculated for 1000 eyes of 500 patients. Results: We concluded from our study, on comparing mean IOP of patients with the age, that IOP was significantly high among the older age patients (60-80 years) (17.43±2.41) as compared to patients with age group between 40-59 years (15.55±1.65). When comparing IOP with the SBP distribution of patients with SBP ≥140mmHg (17.74±2.48) had higher IOP of right eye as compared to those having SBP Comparing <140mmHg (16.07±2.03) (p<0.001), Similarly IOP of left eye was significantly high in patients with SBP ≥140mmHg (17.97±2.51) as compared to those having SBP <140mmHg. The mean CCT between age groups we found that CCT was significantly high among the patients with age group between 40-59 years (547.78±12.59) as compared to patients with age between 60-80 years.

Keywords: intraocular pressure, age, gender, central corneal thickness, blood pressure

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Introduction:

Glaucoma commonly known as the "thief of sight" is a group of eye disorders that lead to progressive damage to the optic nerve. People with glaucoma can lose nerve tissue, resulting in vision loss. It is the second leading cause of blindness, estimated that there are more than expected to increase to 80 million by 2020[1] India has 12 million cases and accounts for 1/5th of the global burden of glaucoma. According to world population projection for 2010 and 2020; India would become second in having the maximum number of glaucoma

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cases.[2] Intraocular pressure (IOP) is the fluid pressure of the eye. As pressure is a measure of force per area, IOP is a measurement involving the magnitude of the force exerted by the aqueous humor on the internal surface area of the anterior eye. IOP is carefully regulated, and disturbances are often implicated in the development of glaucoma, uveitis, and retinal detachment. IOP exists as a fine tuned equilibrium between the production and drainage of aqueous humor. IOP increases with increased systemic blood pressure. Chronic elevation of IOP has been implicated in the pathogenesis of primary open-angle glaucoma (POAG) and other vision-damaging problems.[3]

IOP varies with various factors such as the time of day, heart beat rate, blood pressure level, respiration of day, heartbeat, blood pressure level, fluid intake, and respiration. Age is considered to be one among the several factors that influence IOP[4].The cornea is a transparent, avascular tissue; its diameter measures 11–12 mm horizontally and 10–11 mm vertically. Its refractive index is 1.376. The cornea is aspheric, although its radius of curvature is often recorded as a spherocylindrical convex mirror representing the central anterior corneal surface, also called the corneal cap[5]. Measurement of central corneal thickness (CCT) and endothelial cell parameters is important when undertaking a functional and morphologic evaluation of the cornea for diagnostic purposes or before various surgical interventions. The normal CCT is around 510–520 microns.CCT can be measured via several methods, although ultrasound pachymetry is still the gold standard. This is performed by direct apposition of an ultrasound probe to the anterior corneal surface. The advantages consist of ease of use, reliability and reasonable cost. When performing this technique, patients need to receive topical anaesthesia because of the direct contact of the probe with the cornea. To place the ultrasound probe perpendicular to the cornea may also cause difficult repeatability. Several newer technologies have demonstrated better repeatability and reproducibility; including optical coherence tomography[6].IOP is measured by applanation tonometry, which gives an estimate of the pressure inside the anterior eye based on the resistance to flattening of a small area of the cornea. Pressures of between 11 and 21 mmHg are considered normal, and diurnal variance of IOP is expected, with higher pressures typically found in the morning. While the mainline modality for measurement of IOP remains Goldmann applanation tonometry (GAT), rebound tonometry using portable tonometers has emerged as a practical measurement of IOP in the acute setting. These two modalities, however, are not exchangeable according to current research[7].Since the early 1970s there have been several reports on the relationship between CCT and IOP measured with the GAT. It has been reported that thinner corneas result in artificially lower IOP readings and that thicker corneas cause artificially high IOP readings, thus producing apparent normal tension glaucoma (NTG) and ocular hypertension (OHT) respectively. This has become more of a practical problem recently with the advent of photorefractive keratectomy for myopia where there is artificial thinning of the central cornea, possibly creating underestimates in central applanation tonometry.

IOP has been found to be associated with systemic blood pressure levels in population based studies. The relation appears to be reasonably consistent across the range of values of IOP and both systolic and diastolic blood pressures. It has been postulated that treatment of hypertension may place the eye at relatively increased risk of visual field deficits because of an imbalance in the relation of blood pressure to IOP. This thought has been given credence, in part, because of the clinical dictum that sudden lowering of blood pressure is associated with loss of visual field in some people[9].The present study is an attempt to establish the correlation between the intraocular pressure with age, blood pressure and central corneal thickness

Materials and Methods:

This cross-sectional observational study was conducted in Out Patient Department of Ophthalmology, Index Medical College, Indore.

Inclusion Criteria:

Patients giving consent for the study, between the age ≥40 and ≤80 years of either gender. Patients with or without any grade of senile

cataract and with or without refractive error (WITH MILD GRADE MYOPIA ONLY) with Anterior chamber Van Herrick grading of >II.

Exclusion Criteria:

Patients with any ocular pathology or surgery in either eye. Patients already diagnosed with Glaucoma along with any ocular pathology in either of the eye and wearing contact lens in last 1 week. Patients with Van Herrick grading of ≤ II were excluded. Moderate grade and high grade myopia, known case of diabetes taking or not taking medications, known case of hypertension taking medications and patients with cardiovascular pathology were also excluded.

Place and Procedure:

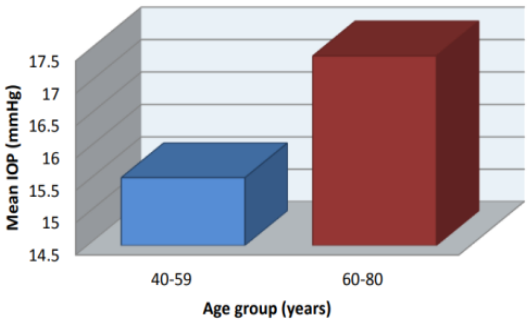
After obtaining informed consent, blood pressure measurement with complete ophthalmic examination, including slit lamp and fundus examination. IOP was measured with Goldman Applanation Tonometer (GAT, Carl Zeiss Meditech AG). One reading was taken from each eye. If the IOP reading was greater than 21 mm Hg, a repeat reading was taken and the average of both reading was used for analysis by Goldmann Applanation Tonometry. Three CCT measurements were obtained from each eye with an ultrasound pachymeter (NIDEK US-4000 echoscan) , and the median reading was recorded. Corneal Pachymetry is a non-invasive ultrasonic technique for measuring corneal thickness, and has been used primarily in the evaluation of persons with corneal diseases and in the assessment of persons at risk for glaucoma. Ultrasonic corneal Pachymetry is performed by placing an ultrasonic probe on the central cornea, after the cornea has been anesthetized with a topical anesthetic. A technician can operate the pachymeter and it normally takes less than 30 seconds per eye to complete measurements Systolic and diastolic blood pressures were measured with a sphygmomanometer using a standardized protocol. Blood Pressure was measured with participants seated after 5 minutes of rest in sitting position; this was measured twice, each 5 minutes apart. A third measurement was made if the blood pressures differed by more than 10 mm Hg in systolic and 5 mm Hg in diastolic readings. The mean of the two closest readings was then taken as the blood pressure of that individual.

Result:

Comparison of Right Eye IOP with age.

Age of patients(yrs)	N	Mean±SD (mmHg)	P value
40-59	266	15.55±1.65	<0.001
60-80	234	17.43±2.41	
Total	500	16.43±2.24	

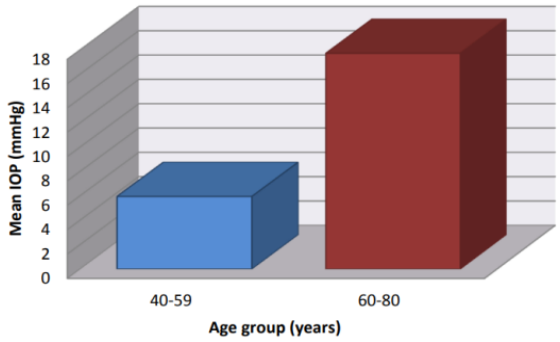
Comparing mean IOP of right eye of patients with the age groups we found that IOP was significantly high among the older age patients (60-80 years) (17.43±2.41) as compared to patients with age group between 40-59 years (15.55±1.65). This comparison was statistically significant (p<0.001).



Comparison of Left Eye IOP with age

Age of patients(yrs)	N	Mean±SD (mmHg)	P value
40-59	266	15.94±1.59	<0.001
60-80	234	17.72±2.74	
Total	500	16.77±2.38	

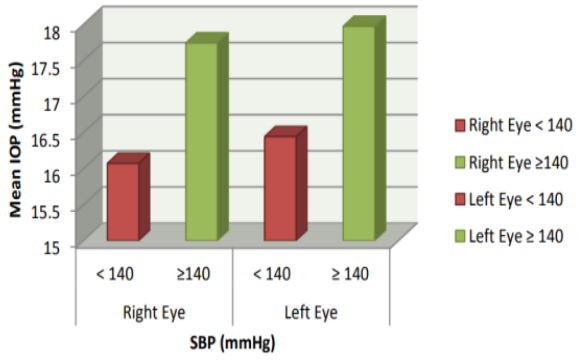
Comparing mean IOP of left eye of patients with the age groups we found that IOP was significantly high among the older age patients (60-80 years) (17.72±2.74) as compared to patients with age group between 40-59 years (15.94±1.59). This comparison was statistically significant (p<0.001).



Comparison of IOP with Systolic Blood pressure

IOP(mm Hg)	SBP(mm Hg)	N	Mean±SD(mm Hg)	P value
Right Eye	≥140	107	17.74±2.48	<0.001
	< 140	393	16.07±2.03	
Left Eye	≥ 140	107	17.97±2.51	0.001
	< 140	393	16.44±2.23	

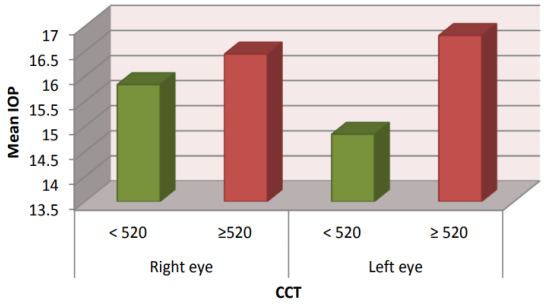
Comparing IOP with the SBP distribution we found that patients with SBP ≥140mmHg (17.74±2.48) had higher IOP of right eye as compared to those having SBP <140mmHg (16.07±2.03) (p<0.001), Similarly IOP of left eye was significantly high in patients with SBP ≥140mmHg (17.97±2.51) as compared to those having SBP<140mmHg (16.44±2.23) (p=0.001).



Comparison of IOP with Central Corneal Thickness

IOP(mm Hg)	MEAN CCT(µm)	N	Mean IOP±SD(mm Hg)	P value
Right eye	≥520	490	16.44±2.25	0.002
	< 520	10	15.83±1.49	
Left eye	≥ 520	490	16.81±2.38	0.001
	< 520	10	14.84±0.57	

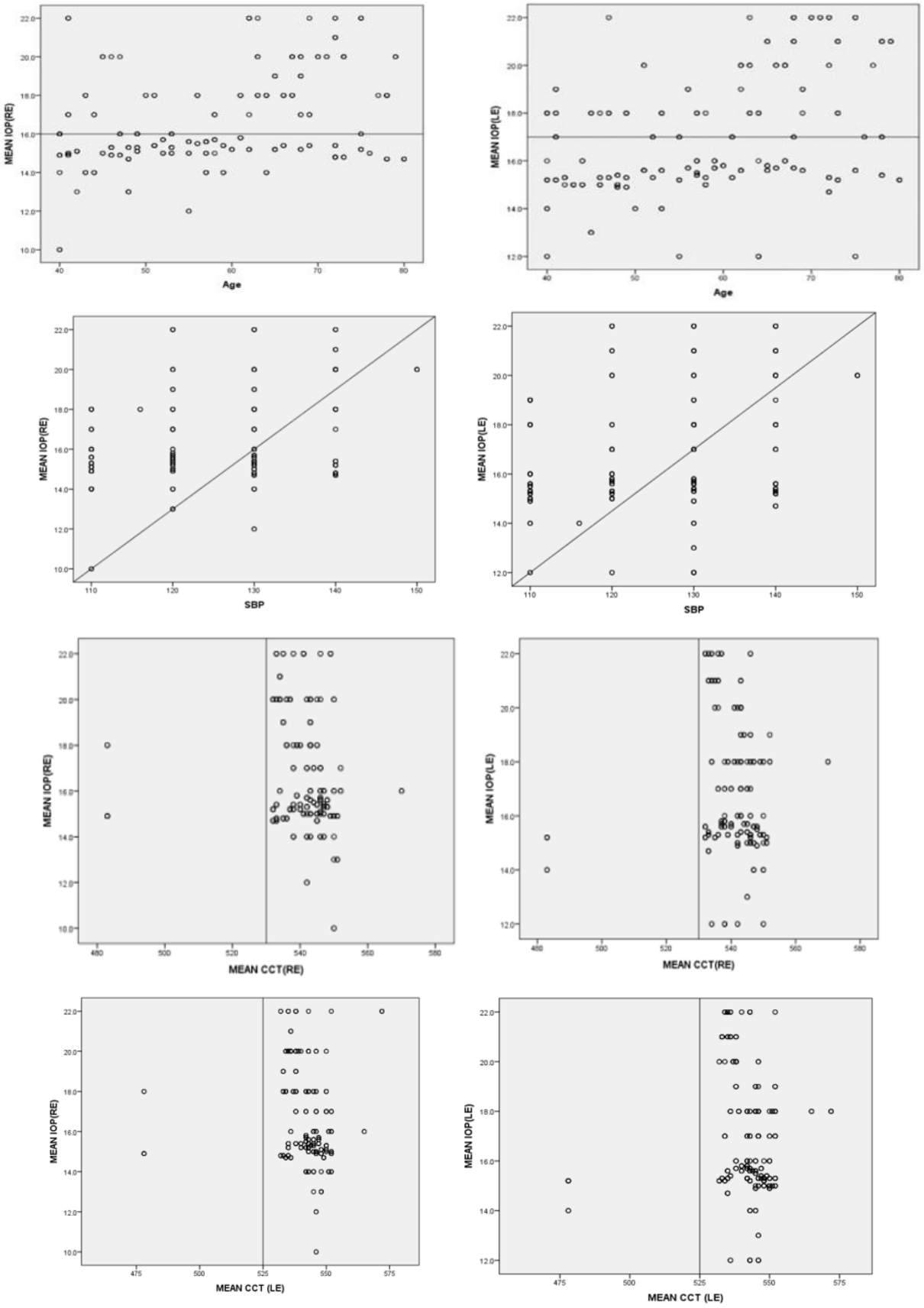
Comparing IOP with the CCT distribution, we found that IOP among the patients with CCT ≥520 (16.44±2.48) was significantly higher as compared to CCT <520 (15.83±1.49) (p=0.002) similarly, IOP of left eye was significantly high in patients with CCT ≥520 (16.81±2.38) as compared to those having CCT <520 (14.84±0.57) (p=0.001).



Correlation between parameters.

		IOP(RE)	IOP(LE)
Age	Pearson Correlation	0.347	0.345
	P value	<0.001	<0.001
SBP	Pearson Correlation	0.356	0.299
	P value	0.001	<0.001
MEAN CCT(RE)	Pearson Correlation	0.223	0.238
	P value	0.006	0.002
MEAN CCT (LE)	Pearson Correlation	0.215	0.164
	P value	0.010	0.032

On Pearson correlation we found that IOP of right eye was positively correlated with Age (r=0.347, p<0.001), SBP (r=0.356, p=0.001), CCT of right eye (r=0.223, p=0.006) and CCT of left eye (r=0.215, p=0.010). Similarly IOP of left eye was positively correlated with Age (r=0.345, p<0.001), SBP (r=0.299,p=0.001), CCT of right eye (r=0.238, p=0.002) and (CCT of left eye r=0.215,p=0.032)



Discussion:

The measurement of central corneal thickness (CCT) and intraocular pressure (IOP) is essential in the clinical assessment of

glaucoma. Recognizing the significance of CCT and IOP in diagnosis, several researchers have investigated their variation among and within various populations[10].Present study evaluated a relationship between the intraocular pressure with age, blood pressure and central corneal thickness.

In present study, out of 500 patients 53.2% belong to the age group of 40-59 years (53.2%). In age group 60-80 years, there were 46.8% patients, where 257 (51.4%) were male and 243 (48.6) were female.Similarly Heidary F et al examined 28 were male (51.90%) and 26 female (48.10%)[11].

In our study, on comparing mean IOP of right eye of patients with the age groups we found that IOP was significantly high among the older age patients (60-80 years) (17.43±2.41) as compared to patients with age group between 40-59 years (15.55±1.65). This comparison was statistically significant (p<0.001).Similarly the mean IOP of left eye of patients was significantly high among the older age patients (60-80 years) (17.72±2.74) as compared to patients with age group between 40-59 years (15.94±1.59). This comparison was statistically significant (p<0.001). Hence, the mean result of IOP of both right eye and left eye of patients were very similar.

SBP was the most interesting and significant determinant for IOP for all persons, and also when stratified into younger and older persons. This confirms the importance of SBP on IOP in several population-based studies.In presen study, when comparing IOP with the SBP distribution we found that patients with SBP ≥140mmHg (17.74±2.48) had higher IOP of right eye as compared to those having SBP <140mmHg (16.07±2.03) (p<0.001), Similarly IOP of left eye was significantly high in patients with SBP ≥140mmHg (17.97±2.51) as compared to those having SBP <140mmHg (16.44±2.23) (p=0.001).

In this study while comparing IOP with the CCT distribution, we found that IOP of RE among the patients with CCT ≥520 (16.44±2.25) and <520 (15.83±1.49) was comparable (p=0.002) whereas, IOP of left eye was significantly high in patients with CCT ≥520 (16.81±2.38) as compared to those having CCT <520 (14.84±0.57) (p=0.001). Hence, we noted positive relationship between IOP and CCT. In the study of Alkhodari et al[12], the mean IOP was 12.5±2.2 and 12.3±2.2 mm Hg for right and left eyes, respectively. A positive correlation was observed between CCT and IOP of the right eye (P<0.001, R=0.358) and CCT and IOP of the left eye (P<0.001, R=0.324). No significant differences were observed in CCT and IOP due to age or gender (P>0.05). There were significant differences in mean CCT and IOP between right and left eyes (P=0.004, P=0.001, respectively).

Conslusion:

Glaucoma is the second leading cause of blindness worldwide. Although the mechanism of the development of primary open-angle glaucoma (POAG) is not fully understood, elevated intraocular pressure (IOP) is considered the most important risk factor. Among vascular factors, systemic hypertension may contribute to increases in IOP via overproduction or impaired outflow of aqueous humour. However, the relationship between glaucoma and blood pressure (BP) remains under debate. A direct and clear relationship between glaucomatous damage and BP level has not been established. Several studies demonstrated that both high and low BP are associated with increased risk of POAG. An increase in BP is associated with an elevated IOP, leading to increased risk of glaucoma.

Results of the present study are in agreement with previous studies; however there are some limitations of the present study like the study sample do not replicates the actual population. Collected data are cross-sectional; hence cannot be assume longitudinal changes in terms of IOP with age and the other parameters, CCT and SBP. Method followed has some flaws like those that the BP was measured only once during the study. A more controlled study is suggested to investigate the relationship between the intraocular pressure with age, blood pressure and central corneal thickness in different age groups.

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References:

1.Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol. 2006 Mar;90(3):262-71.
2.Ramakrishnan R, Nirmalan PK, Krishnada R, Thulasiraj RD, Tielsch JM, Katz J et al. Glaucoma in a rural population of Southern India: the Aravind comprehensive eye survey. Ophthalmol. 2003;110:1484-90.
3.Pardianto G. Recent awareness and consideration of intraocular pressure fluctuation during eye surgery. J Cataract Refract Surg. 2015 Mar;41(3):695.
4.Khurana I. Text Book of Medical Physiology, 1st edn. India: Elseivier, 2006. p. 1183.
5.American Academy of Ophthalmology . Basic and Clinical Science Course. External Disease and Cornea, Section 8. San Francisco, CA: American Academy of Ophthalmology; 2015. pp. 6–39
6.Martin R, de Juan V, Rodríguez G, et al. Measurement of corneal swelling variations without removal of the contact lens during extended wear. Invest Ophthalmol Vis Sci. 2007; 48(7):3043–3050.
7.Sagri D, Lösche CC, Bestges BB, Krummenauer F. [Is There Really Agreement between Rebound and Goldmann Applanation Tonometry Methods? Results of a Systematic Review of the Period 01/2005 to 08/2014]. Klin Monbl Augenheilkd. 2015 Jul;232(7):850-7.
8.Kruse-Hansen F & Ehlers N (1971): Elevated tonometry readings caused by thick cornea. Acta Ophthalmol (Copenh) 49: 775–778.
9.Piltz-Seymour JR, Stone RA. Glaucoma associated with systemic disease. In: Ritch R, Shields MB, Krupin T, eds. The glaucomas. 2nd ed. St Louis: Mosby, 1996:1157–76.
10.Shih CY, Graff Zivin JS, Trokel SL, Tsai JC (2004) Clinical significance of central corneal thickness in the management of glaucoma. Arch Ophthalmol 122: 1270–1275.
11.Heidary F, Gharebaghi R, Wan Hitam WH, Naing NN, Wan-Arfah N, et al. (2011) Correction: Central Corneal Thickness and Intraocular Pressure in Malay Children. PLOS ONE 6(12)
12.Alkhodari HT. Distribution of central corneal thickness and intraocular pressure in emmetropic eyes of healthy children of Palestine: a representative cross-sectional study. Int J Ophthalmol. 2019;12(3):496–503.