

Correlation between Intra Ocular Pressure, Central Corneal Thickness and Glaucoma Stage in Patients with Primary Open Angle Glaucoma

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Pak J Ophthalmol 2010, Vol. 26 No. 4

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Received for publication
June' 2010
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Purpose: To determine the correlation between central corneal thickness (CCT), Intra Ocular Pressure (IOP) and glaucoma stage as assessed by cup to disc ratio (CDR) in patients with primary open angle glaucoma (POAG)

Material and Method: Patients with Primary open angle glaucoma were included. Patients under 35 years of age, with some corneal and retinal problems and secondary open angle glaucoma were excluded from study. After ultrasound pachymetry, intraocular pressure was measured using Goldmann applanation tonometry. Cup to disc ratio was assessed and disc photograph taken. Pearson's correlation coefficients were calculated to assess the associations between central corneal thickness, intra ocular pressure and vertical cup to disc ratio. P value lower than 0.05 was defined as statistically significant.

Results: One hundred and fifty three eyes of 86 patients with POAG were examined. Mean corneal thickness was 535 um and mean Intra ocular pressure was 30mmHg. A significant negative correlation was detected between central corneal thickness and cup to disc ratio ($r=-0.204$, $P=0.031$). Eighty-eight percent of patients with $CCT<500\mu m$ and 80% patients with $CCT 500-519\mu m$ presented with 0.7 to total cupping but as the CCT increases, this ratio became equal or reverse.

Conclusion: Glaucoma patients with thin central corneal thickness are more likely to be found at an advanced stage of the disease. Under estimation of intra ocular pressure by Goldmann applanation tonometry could be one causative factor.

Intra ocular pressure (IOP) is one of the most important parameters in the diagnosis and treatment of glaucoma. Goldmann applanation tonometry (GAT) is still the gold standard for its measurement¹⁻².

A positive linear correlation between central corneal thickness (CCT) and IOP as determined by applanation tonometry has been described by several groups suggesting that GAT results in under estimation in thin corneas and overestimation in thick corneas³⁻⁷.

The OHTS study defined decreased CCT as one of the risk factors for ocular hypertensives to develop manifest glaucoma⁸. Both reduced CCT and enlarged cup to disc ratio (CDR) were found to be associated with progression to disease in ocular hypertensives. Herndon et al⁹ described CCT as a powerful clinical factor in determining glaucoma severity at initial examination by a glaucoma specialist. To further delineate the association, we evaluated the correlation between CCT, IOP and glaucoma stage as assessed by

cup disc ratio in patients with primary open angle glaucoma (POAG)

MATERIALS AND METHODS

A random sample of primary open angle glaucoma patients was included in this study. All participants were recruited between July 2007 and June 2008 from outpatient department of ophthalmology LUMHS. The diagnosis of POAG was based on patients having IOP of 22mmhg or higher at initial visit, characteristic glaucomatous optic neuropathy with diffuse or focal optic rim thinning, cupping or nerve fiber layer defect indicative of glaucoma and corresponding visual field loss. All pt with POAG above 35 years of age were included but those below 35yrs of age, pt: with some corneal and retinal disease and secondary open angle glaucoma (pseudo exfoliation and pigmentary glaucoma) were excluded from this study. Patients who had undergone any corneal surgery were not included in this study. All patients gave written informed consent before enrollment. GAT was calibrated weekly and performed in the way described by Goldmann and Schmidt¹⁻² using slit lamp (Inami. JAPAN). CCT was assessed as an average of 5 consecutive measurements using an ultrasound pachymeter (Opticon 2000 Pacline Italy).

The regular visits included a thorough ophthalmologic examination of the anterior and posterior segments. Cup-to-disc ratio (CDR) in both the vertical and horizontal dimension was reassessed through a dilated pupil with a +90 or +72 diopter lens having the patient in a sitting position at the slit lamp.

Data entered and analyzed on SPSS version 11. Pearson's correlation coefficient were calculated to assess the association between CCT, IOP and CDR. A P Value lower than 0.05 was defined as statistically significant.

RESULTS

A total of 153 eyes of 86 patients with primary open angle glaucoma were evaluated. Out of that 60 were male and 26 female. Patients were divided into four groups according to age to observe the difference of central corneal thickness (CCT), intraocular pressure (IOP) and vertical cup disc ratio (CDR) with increasing age (Table 1). The mean differences of CCT, IOP and CDR was insignificant between different age groups. (P=0.839, 0.751 and 0.648 respectively).

The mean values of Age, IOP, CCT and CDR was 57.22 ± 10.6 yrs, 29.4 ± 6.0mmhg, 535 ± 33um and 0.71 ±

19 respectively. The mean differences of these values between gender was insignificant. (P=0.376, 0.297, 0.968 and 0.602 respectively) (Table 2).

According to CCT values, patients were divided into subgroups. An increase in CCT was associated with slight and insignificant (p=0.154) elevation of IOP but majority of patients with thin cornea (<500-519um) presented with advanced stage of disease i.e advanced cup disc ratio as compared to patient with thick corneas (>540um) which was statistically significant (p=0.031) (Table 3).

Eighty-eight percent of patients with CCT<500um and 80% patients with CCT 500-519um presented with 0.7 to total cupping but as the CCT increases, this ratio became equal or reverse (Table 4).

DISCUSSION

Our glaucoma sample of 153 eyes revealed an average CCT of 535 um. The effect of CCT on ocular hypertension and normal tension glaucoma has already been well documented¹⁰⁻¹⁶. In our patients of POAG who had a thinner CCT tended to have more severe glaucomatous damage on initial examination. Central corneal thickness was the most consistent predictor of degree of glaucomatous damage as measured by outcome variables.

It has been suggested that a thicker CCT may be protective against glaucomatous damage, since CCT in ocular hypertensive patients tends to be thicker than a POAG patients^{11-12, 16}.

It is well known that IOP measured by applanation should be adjusted to correct for CCT measurements that are higher or lower than the mean CCT of approximately 545um in the general population¹⁴.

In our study the IOP is high in individuals with thick cornea (hence an early presentation at hospital and less advanced disease) and low in thinner cornea (this delaying referral until more advanced disease is evident).

Lyamu¹⁷ and Leon¹⁸ reported CCT as a better predictor than IOP in identifying those at higher risk of developing POAG when combined with some ocular risk factors. Christoph et al¹⁹ found significant negative correlation between central corneal thickness and cup disc ratio (P>0.005). The mean CCT was 538um±32um and surprisingly more excavated optic nerve heads (0.72±0.17) among Asian population as compared to African Americans and Caucasians. In

our study the mean CCT is 535um ±33um and mean CDR is 0.71 ± 0.19 (P 0.03).

Table 1: Comparison between age groups

Age groups	Eyes 153	CCT Mean±SD	IOP Mean±SD	VCD Mean±SD
35-44	21	530.8 ±29.6	27.9 ± 4.9	0.63 ± 0.17
45-54	35	538.9 ±35.8	29.3 ±7.2	0.76.0.17
55-65	63	535 ±37.2	30.4 ±6.5	0.72 ±0.21
Above 65	34	533.7 ±23.9	28.7 ±5.9	0.73 ±0.18
P-Values		0.839	0.751	0.648

*By Pearson’s correlation.

Mean difference of CCT, IOP and VCD ration was insignificant between different age groups.

Table 2: Comparison between gender

	Male Mean ± SD	Female Mean ± SD	P- Values
Age (Years)	56.7 ± 11.2	58.7 ± 8.9	0.376
IOP (mmhg)	29.8 ± 6.4	28.4 ± 6.1	0.297
CCT (µm)	535.1± 29.6	534.8 ± 41.4	0.968
VCD Ratio	0.71 ± 0.19	0.73 ± 0.2	0.602

Table 3: IOP and VCD in CCT groups

CCT Groups	Eyes 153	IOP	VCD
		Mean ± SD	Mean ± SD
< 500 µm	8	25.6 ± 6.0	0.75 ± 0.12
500 – 519	50	28.8 ± 5.4	0.77 ± 0.18
520 – 539	28	30.0 ± 8.0	0.68 ± 0.18
540 – 559	27	29.7 ± 6.1	0.67 ± 0.19
560 – 579	22	30.7 ± 7.4	0.67 ± 0.23
580 – 600	12	30.9 ± 4.5	0.68 ± 0.23
> 600 µm	6	30.3 ± 4.6	0.65 ± 0.26
P - Values		0.154	0.031
Pearson Correlation (r)		+ 0.136	- 0.204

Table 4: CD Ratio Vs CCT

CCT Groups	Eyes 153	CDR Groups	
		0.3 – 0.6	80.7 – 1.0
< 500 µm	8	1 (12%)	7 (88%)
500 – 519	50	10 (20%)	40 (80%)
520 – 539	28	11 (40%)	17 (60%)
540 – 559	27	12 (45%)	15 (55%)
560 – 579	22	13 (59%)	9 (41%)
580 – 600	12	6 (50%)	6 (50%)
> 600 µm	6	3 (50%)	3 (50%)

In our study 88% of the patients with CCT <500um and 80% of the patients with CCT <520 presented with advanced cupping, Similar findings are reported by Tharwat et al²⁰ that thin corneas (CCT < 540) are likely to develop greater glaucomatous optic nerve damage. The mean CCT was 518±31 and mean CDR was 0.67±0.31 in thin cornea’s group.

There is no universally acceptable and correct algorithm that is available as a CCT-tonometric correction factor. Thus it is difficult to obtain a true estimate of the effect of CCT on IOP and hence difficult to substantiate or negate any bias issue due to improper measurement of IOP. Neither can undebatable proof of any physiological biomechanical relationship between CCT and the support structures of the optic nerve be determined. However results of the present study suggest that in eyes with glaucoma, thinner corneas are associated with morphological changes of the optic nerve head (increase cup depth and volume) .that might reflect an increase susceptibility to glaucomatous optic neuropathy. Much remains unknown and many further studies are required to unravel the mysteries of the pathogenesis of glaucomatous optic neuropathy and any relationship that there may be with CCT. Use of alternative tonometers, such as the Dynamic ContourTonometer²¹ or the Ocular Response Analyzer²², which have been reported to be independent of CCT, may prove useful in future research.

The present study has limitation in that this is a hospital based study and not a population based study. There may be some referral bias in our patient population. Patients referred to a tertiary care hospital

may have more advanced, intractable glaucoma than those in the general population and therefore may not represent the majority of POAG patients.

CONCLUSION

A significant correlation was found between CCT and CDR, indicating that patients with thin corneas are more likely to be found in an advanced stage of the disease. Measuring CCT in glaucoma patients may help identify those patients who are at higher risk of developing severe glaucomatous sequelae thus enabling the ophthalmologist to treat their disease more aggressively.

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