ORIGINAL ARTICLE

IMPORTANCE OF PACHYMETRY IN DIAGNOSIS OF OPEN ANGLE GLAUCOMA

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ABSTRACT

Objective: The objective of the study was to establish relation between Central Corneal Thickness (CCT) and Intra-Occular Pressure (IOP) in Open Angle Glaucoma (OAG).

Methods: A prospective study of randomly selected 100 cases was conducted where-in IOP was measured using Goldmann Applanation Tonometer and CCT was measured using Accutone Pachymeter. According to the CCT, patients was grouped into 3 categories: Group A - patients with normal CCT (510-530μm), Group B- patients with low CCT(<510 μm) and Group C -patients with high CCT(>530μm). Patients with history of any condition altering CCT were excluded. The IOP was adjusted using the correction nomogram : Corrected IOP = Applanation IOP + [5 mm Hg(mean normal - measured CCT μm) / 70 μm]. The measured IOP & corrected IOP was compared in each group and the data so obtained was analysed using the non-parametric chi square test.

Result: Based on our findings, p value in group A with normal CCT is 0.9 (not significant), p value in group B with low CCT is 0.05 (significant) & in group C with high CCT is 0.029 (significant). Without the aid of corrected IOP 5 patients in group B having high IOP would have been wrongly labelled as having normal IOP & 9 patients in group C would have been wrongly labelled as having glaucoma.

Conclusion: Thus CCT should be routinely taken into consideration as part of the comprehensive eye exam while measuring IOP, as knowledge of an individual's CCT provides valuable information about the accuracy of IOP status.

Keywords: Glaucoma, Central corneal thickness, Open angle glaucoma, Applanation tonometry, Pachymetry.

INTRODUCTION

Glaucoma is one of the leading causes of preventable blindness. In nearly all cases blindness due to glaucoma is preventable if the disease is detected early and the proper treatment is implemented.

Glaucoma is an optic neuropathy characterized by a typical appearance of optic nerve head and characteristic visual field loss. [1] The diagnosis of glaucoma is based on factors like intra ocular pressure (IOP), optic disc damage (optic nerve fiber layer damage) and specific visual field defects. Increased IOP is the only known causal risk factor that can be therapeutically manipulated.[1] Goldman applanation tonometry, the current gold standard for measurement of IOP, [2] is based on Imbert-Fick's law. It states that when corneal area of 7.35 mm [2] is applanated, the surface tension due to the tear film will counterbalance the resistance to amount of indentation of cornea, thus making it unnecessary to consider rigidity of globe and surface tension of tear film in applanation tonometry.[3] Goldman assumed normal central corneal thickness (CCT) of 520 μm for his applanation tonometer. He himself discussed the influence of variations of CCT on IOP measured by applanation tonometry.[4] But he felt that significant variation in CCT occur rarely.

A relation between increased corneal thickness and IOP has been reported earlier.[5,6] Studies in eyes with manometrically controlled IOP have demonstrated a significant difference between actual IOP and applanation tonometry readings. This difference was related to CCT, underestimation of IOP was as much as 4.9 mm of Hg in thin corneas and overestimation up to 6.8 mm of Hg noted in thick cornea. [7,8]So, it has been suggested that measurement of corneal thickness is mandatory for accurate interpretation of applanation tonometry.

It has been calculated that, applanation tonometry under or overestimated IOP by 5mm Hg for every 70 μm of corneal thickness.[8] A correction factor for CCT measurement that differs from normal CCT was proposed as follows:

Corrected IOP= applanation IOP + [5 mm Hg (mean normal CCT – measured CCT μm) / 70 μm]

There are many studies regarding importance of CCT in diagnosis of glaucoma particularly in ocular hypertensive group. Very few studies are conducted in normal tension glaucoma. Here, we present a study in pachyme-

try was used as the basis for diagnosing glaucoma and deciding the treatment modalities and also we have included a lower CCT group in it.

Aim of this study is to know intraocular pressure more accurately. Direct manometric measurement of IOP is most accurate and possible, but not practical for clinical use. In clinic we have to use an indirect method for which the Goldman applanation tonometry is most reliable. This method is accurate for normal CCT. Variations in CCT changes the resistance of cornea to indentation. A thinner cornea requires less force to applanate leading to underestimation of IOP, while thicker cornea would need more force to applanate thus resulting into overestimation of IOP.

We have measured CCT of all the patients in our study & calculated correct IOP (pachymetry adjusted IOP).

MATERIALS AND METHODS

This study was conducted at Dhiraj Hospital, SBKSMIRC, Vadodara after taking ethical approval of institutional ethical committee. It was a prospective, non interventional, comparative study which included 200 eyes of 100 patients who attended the outpatient department over a period of 1 year and 6 months.

Inclusion Criteria: Patients between the age of 40 to 60 years regardless of gender were taken into study.

Exclusion Criteria: Patients with history of any intraocular or corneal surgery, wearing contact lenses, corneal edema, corneal opacities, corneal astigmatism more than 3D and any other condition which might affect corneal thickness. Patient with optic nerve or intracranial diseases, retinal pathology, ocular inflammation or infection were excluded from the study. Patients with systemic disease like Diabetes were also excluded.

Informed consent was taken of all the patients. Detailed history regarding refractive errors, glaucoma, use of topical steroids, use of contact lenses, history of refractive surgery or laser was obtained. Then the BCVA was recorded. Thorough Slit Lamp Examination was done to rule out any anterior segment pathology, corneal pathology & infections. The eye was aneasthetized by topical proparacaine 0.5% and using the fluorescein strips 2 %, IOP was measured in both eyes using Goldmann

Applanation Tonometer CCT was measured with ultrasonic pachymeter. After anesthetising the cornea with topical proparacaine 0.5% and the Patient looking in primary position of gaze, the pachymeter probe was placed on the centre of the cornea. Five measurements were taken from each eye and the average was used for analysis

Corrected IOP was computed using the following nomogram:

Corrected IOP = applanation IOP + [5 mm Hg (mean normal – measured CCT µm) / 70 µm]

Patients were then grouped into 3 categories based on the above findings:

Group A: Patients With Normal CCT (510 TO 530 µ)
Group B: Patients With Low CCT (<510 µ)
Group C: Patients With High CCT (>530 µ)

In each of the 3 groups the applanation IOP was compare with the corrected IOP.

(Adjusted IOP) normal= IOP after pachymetry correction<21 mm of hg
Abnormal= IOP after pachymetry correction>21 mm of hg

Statistical Analysis: Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) was used to analyze and present data. Data was analyzed using the non-parametric chi square test. The level of significance was chosen at $p <= 0.05$.

RESULTS

In group A (n=35), 9 patients found to be glaucomatous stayed abnormal after pachy adjusted IOP correction of their IOP's, in group B (n=31) , 20 patients were found to be having normal IOP and 11 high IOP which after pachy correction changed to 15 normal and in high IOP group 16 patients (P=0.20). In group C (n=34) there were 13 normal and 21 abnormal high IOP's which became 22 and 12 respectively after correction (p=0.029).

Table 1: Central Corneal Thickness and pachy adjusted IOP correction in diagnosing Open Angle Glaucoma

	Normal IOP*	Abnormal IOP	P Value
Group A- Normal CCT (510 - 530µm) (N=35)			
Uncorrected IOP	26	09	-
Corrected IOP	26	09	
Group B- Low CCT (<510µm) (n=31)			
Uncorrected IOP	20	11	0.20
Corrected IOP	15	16	
Group C- High CCT (>530µm) (n=34)			
Uncorrected IOP	13	21	0.029
Corrected IOP	22	12	

CCT = Central Corneal Thickness; IOP – Intra Ocular Pressure; *IOP 10-21mmhg

This study led us to the similar findings as already mentioned in the literature regarding the relationship between IOP and pachymetry. Our study supports the emphasis of doing pachymetry right at the time of the first suspicion of glaucoma during primary checkup of the patient.

It helped us to filter out 26.5 % patients from high IOP to the normal IOP, and diagnosed 16.1 % patients from normal IOP to abnormal increased IOP (glaucomatous) group. It also helped us to set the target IOP lower than calculated in group-B and higher than calculated in group-C thus medical and or surgical requirements of

the individual patients were modified to fit patient's actual condition.

Highest incidence of low tension glaucoma was found in group B and that of the ocular hypertension in group C, after adjustment of IOP to corneal thickness factor . In group C about26.5 % of patients were labeled normal after adjusted IOP and stayed so in the follow up .The group B showed 16.1% of patients with normal IOP are actually having glaucoma after adjusted IOP and were treated accordingly. In group A there was no variation found the abnormal patient stayed abnormal after adjusted IOP.

DISCUSSION

IOP is the only measurable and manipulatable casual risk factor for glaucoma.[1]

Therefore the accuracy of its measurement is of utmost importance. Direct manometric measurement of IOP is not practical as it is invasive.[8] For clinical use, we rely on indirect measurement using tonometer. In tonometry, goldmann applanation tonometer is the gold standard for measuring IOP. This indirect estimation is practical but it is not faultless because its accuracy holds good for corneal thickness raging 510-530 micron but variation are observed in lesser and higher thickness.

The diagnosis of OHT, POAG and NTG is made on the basis of an arbitrary IOP cut off point of 21 mm hg which is based on statistical grounds used primarily for screening purpose not for diagnostic purpose but still it is in its clinical use.[1] Any factor that alters the value of IOP can therefore lead to a misclassification of the patient .one such factor is corneal thickness.

A relative minor change in CCT can produce a statistically significant change in mean IOP measurement .This fact suggest that CCT may be more important in the overall management of glaucoma than previously suspected and great impact on the IOP values which fall around the "magic" 21 mm hg.

It is evident from our result that many patient with high IOP without any other glaucomatous [9,10] features might be having normal but thicker cornea without any risk for glaucoma. Also there were certain patient with perfectly normal IOP but with or without other glaucoma features were actually at risk of glaucoma.

In this study the values generated for CCT are consistent with the findings of the earlier studies and there is definite direct relationship of CCT with IOP values.

About 26.5 % of patients in group- C were labeled normal and given no treatment and in group-B 16.1 % of more glaucoma were diagnosed , treated and their target IOP's were set as per the adjusted IOP.

Thus 9 out of 21 patients were labeled normal which would have been otherwise labeled as ocular hypertensive and 5 out of 20 were labeled glaucomatous who were found otherwise normal and managed accordingly.

We used ultrasound pachymetry to measure central corneal thickness as it has been shown to have least inter-observer and intra-observer variability than the optical method. In addition, readings taken from central 2-3 mm of the cornea have been shown to be more replicable than from paracentral or peripheral locations in the cornea.[11]

Finally, in the management of glaucoma the decision to treat or reduce IOP to a certain level (target IOP) was adjusted according to CCT corrected baseline IOP. Our study thus confirms that CCT can be confounding factor while recording IOP in any patient being a glaucoma suspect. The patient may thus be erroneously put into OHT group leading to unnecessary prolonged treatment and follow up and more disastrously some of the early glaucoma cases with normal IOP, optic discs and fields but with thinner cornea may be missed and may end up into advanced glaucoma when they report later on.

In conclusion, the measurement of central corneal thickness is a valuable examination which improves clinical decision making, especially if the other clinical findings do not seem to correlate with the IOP. This further helps to prevent erroneous labeling of the normal patients as ocular hypertensive and primary open angle glaucoma patients as normal or having normal tension glaucoma.

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