Re-Evaluation Of Ocular Hypertensives By Pachymetry

D Deshmukh, R Al Saidi, A Alugail

Citation

D Deshmukh, R Al Saidi, A Alugail. *Re-Evaluation Of Ocular Hypertensives By Pachymetry*. The Internet Journal of Ophthalmology and Visual Science. 2023 Volume 13 Number 1.

DOI: 10.5580/IJOVS.56774

Abstract

Purpose: To study central corneal thickness (CCT) in ocular hypertensives in Omani population and to apply the pachymetry findings in modifying the diagnosis of Ocular Hypertension.

Design- Observational study

Method: The central corneal thickness was evaluated using pachymeter (DGH Tech model 550) in 43 eyes of 25 patients with proven primary open angle glaucoma, 50 eyes of 25 patients initially diagnosed as ocular hypertensives, and the results were compared with that of age matched normal individuals at Department of Ophthalmology, Armed Forces Hospital, Muscat, Oman. Student “t” test was used for statistical
analysis.

Results: Male: female ratio was 1:1. Mean age of patients was 37.1 years (range 20-54 years) Mean central corneal thickness was 572.6 microns (range 535-739 microns). Nine (N=18) out of 25 patients (36 %) had corneas thicker than 600 microns (mean 608, range 600-739 microns). In 13 (N=26) out of 25 patients (52%) with an average initial recorded IOP of 24± 2 mmHg, the corrected IOP was 20± 2 mmHg.

Conclusions: Increased corneal thickness in ocular hypertension may lead to an overestimation of IOP. 52 % of normal cases were misclassified as ocular hypertensives. Measurement of central corneal thickness is advisable in ocular hypertensives and in borderline cases when the clinical findings do not correlate with the applanation IOP.

INTRODUCTION

Glaucoma is defined as chronic optic neuropathy characterized by optic nerve cupping with characteristic visual field changes which may or may not be associated with raised intraocular pressure.[1] Intraocular pressure is the only modifiable risk factor in glaucoma that can be manipulated therapeutically.

Goldmann applanation tonometry, still considered the gold standard for measurement of IOP is based on Imbert-Fick law.[2] It has been observed that when area of applanation is 7.35mm, surface tension due to tear film counterbalances resistance to indentation of cornea so that ocular rigidity need not be considered.[3] But recent evidence indicates that there are a number of other factors (corneal astigmatism, thickness) that affect accuracy of applanation tonometry.

Variations in corneal thickness affect resistance of cornea to indentation so this no longer is balanced by tear film surface tension which affects accuracy of IOP measurement by applanation tonometry. A thinner cornea requires less force to applanate leading to underestimation of true IOP while reversely thicker cornea needs more force thus giving overestimation of true IOP. Goldmann earlier thought that significant variations in central corneal thickness (CCT) occur rarely and so he assumed it to be 520 um for his instrument. A positive correlation exists between increased corneal thickness and IOP. So it has been suggested by many that measurement of CCT is necessary for the accurate interpretation of applanation tonometry and GAT readings should be complimented with CCT measurements.[12,13]

Nomograms, based on varying CCT, exist for adjusting GAT readings in normal eyes.[14,15,16] There is much controversy regarding these scales and no single one has

proven to be satisfactory as the relationship between IOP and CCT is variable. What is certain is that CCT measurement can allow for a more accurate estimate of true IOP. In addition, measuring CCT was recommended by the ocular hypertension studies[17,18] (OHTS) as it is a predictive factor for the conversion of OHT to POAG.

It has been calculated that applanation tonometry under/overestimates IOP by 5mmHg for every 70 um of corneal thickness.[4] So, a correction factor for IOP to adjust for CCT measurement is proposed (table 1). This study was undertaken to compare corneal thickness in patients with glaucoma, ocular hypertensives, and normal subjects in the Omani population and to apply the pachymetry findings in modifying the diagnosis of ocular hypertension.

Table 1

Correction table used for adjusting IOP based on central corneal thickness based on Ehlers et al .

Central Corneal Thickness (Microns)	Adjustment in IOP (mm Hg)
445	+7
455	+6
465	+6
475	+5
485	+4
495	+4
505	+3
515	+2
525	+1
535	+1
545	0
555	-1
565	-1
575	-2
585	-3
595	-4
605	-4
615	-5
625	-6
635	-6
645	-7

MATERIALS AND METHODS

This study was conducted at the Armed Forces Hospital; Muscat, Oman. 75 Patients were included in this masked, controlled, prospective study. Based on criteria below, patients were classified into three group, namely as patients with glaucoma (n=43), ocular hypertension (n=50), and normal (n=50)

Inclusion Criteria

Group 1- Glaucoma: IOP > 21 mmHg prior to treatment; Open angles on gonioscopy; Glaucomatous optic discs +/- nerve fibre layer defects; Glaucomatous visual field defects glaucomatous field defects fulfilling at least two of Anderson's criteria on white-on-white Humphrey perimetry.5

Group 2- Ocular hypertension: IOP >21 mmHg at least on two consecutive visits; Normal optic discs with no nerve fibre layer defect; open angles on gonioscopy; No glaucomatous visual fields defects

Group 3- Normal: IOP < 21 mmHg; open angles on gonioscopy; normal optic discs and no suspicion of any form of glaucoma. Normal subjects were selected from hospital staff, relatives and people accompanying patients

Exclusion Criteria

Any anterior segment pathology affecting corneal thickness

Previous anterior segment or corneal surgery

Previous corneal laser refractive surgery

Use of contact lenses which might affect corneal thickness

Angle closure glaucoma or combined mechanism glaucoma

Methods

During the above-mentioned period patients were randomly selected from OPD and grouped in three groups. After determination of best corrected visual acuity complete ocular examination was performed. This included slit lamp examination, gonioscopy, applanation tonometry, slit lamp biomicroscopy using 90 D or 78 D lens. Central corneal thickness was measured using ultrasound pachymeter (DGH Technology, USA Model 550). Automated perimetry was performed on all patients using 30-2 program with SITA STD on a Humphrey Field Analyzer. NFL analysis was obtained with OCT for patients with glaucoma and ocular hypertension. IOP was checked for 2 consecutive visits at different times for all patients in the ocular hypertensive group.

RESULTS

Male: female ratio was 1:1.

The mean CCT was highest (0.572 mm) in ocular hypertensive group as compared to normals (0.539 mm) and glaucoma patients (0.533 mm) (Graph -1)

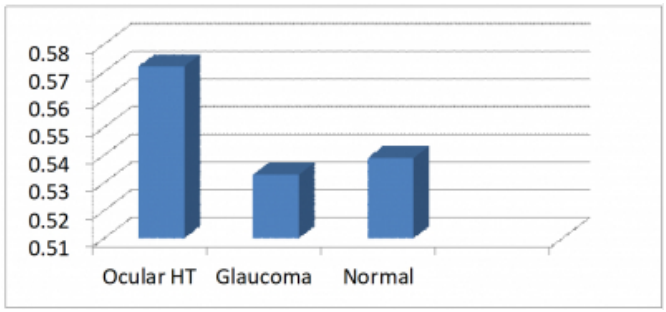
The mean age was highest in the glaucoma group (50 years); and the ocular hypertensives had the lowest mean age (37.1 years). Mean age for normals was 45 years (Graph-2)

Nine (N=18) out of 25 patients (36 %) had corneas thicker than 600 microns (range 600-739 microns). In 13 (N=26) out of 25 patients (52%) with an average initial recorded IOP of

24± 2 mmHg, the corrected IOP was 20± 2 mmHg.

Graph 1

Mean CCT



Graph 2

Mean Age

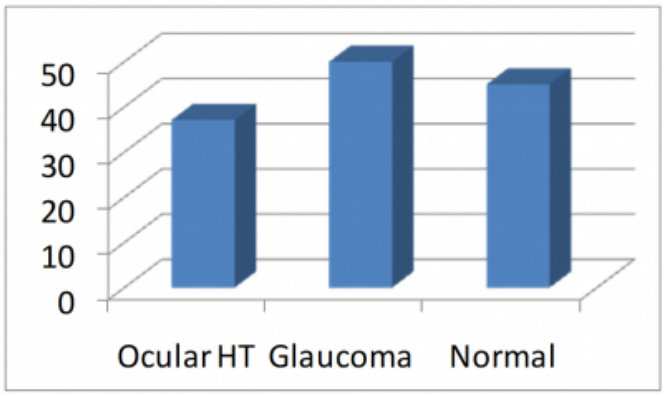


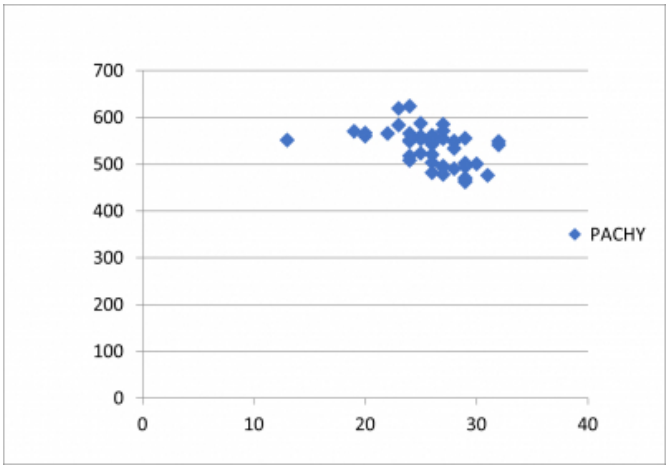
Table 2

Mean age, IOP and CCT in 3 groups

		Mean Age	Mean IOP	Mean CCT
Ocular HT	37.1 yrs	23.7 mmHg	0.572 mm	
Glaucoma	50 yrs	25.7 mmHg	0.533 mm	
Normal	45 yrs	18 mmHg	0.539 mm	

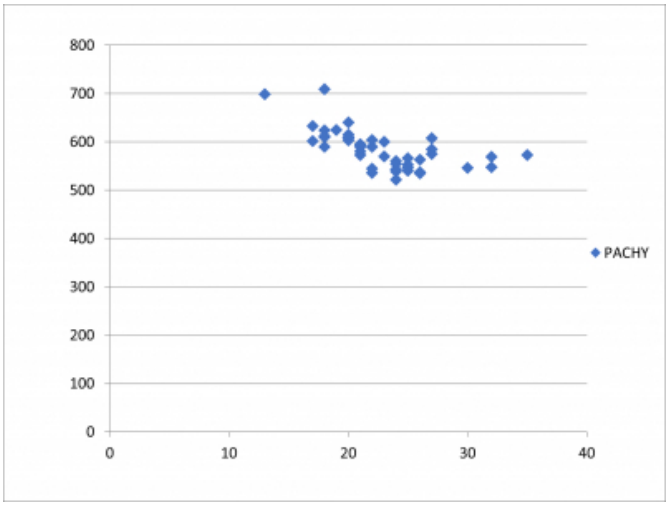
Graph 3

Distribution map of central corneal thickness and intraocular pressure values in Glaucoma group



Graph 4

Distribution map of central corneal thickness and intraocular pressure values in Ocular hypertension group



DISCUSSION

Intraocular pressure is the only modifiable risk factor for glaucoma and it is therefore of outmost importance to measure it accurately. As direct manometric reading is not practical we have to rely on indirect methods of measuring IOP. Of these applanation tonometry is most accurate but recently it has been observed from manometric studies that measurement of IOP by applanation is affected by corneal thickness and is overestimated in thicker corneas.

The diagnosis of glaucoma, ocular hypertension and normal tension glaucoma is based on arbitrary IOP cut off point of 21 mmHg. So, any factor that alters the value of IOP can lead to misclassification of patient.

It is obvious from the study results that many patients were classified as glaucoma or ocular hypertensives but without any glaucomatous damage because of thicker corneas. CCT values in our study are consistent with earlier studies[6,7,8,9,10,11] and a definite relationship of CCT with IOP values was found. Corneas in ocular hypertensives were significantly thicker than those of glaucoma and ocular normals (mean CCT- 0.572 mm in ocular hypertensive group, 0.539 mm in normal and 0.533 mm in glaucoma patients (Table-2)

The IOP in the ocular hypertensives corrected for the thicker CCT resulted in corrected IOPs of 21mmHg or less in 36 % of ocular hypertensives. If the cutoff value was raised to 22mmHg or less, the number of ocular hypertensives found to have "normal" pressures increased to 13 (52 %). Hence, at least 9 of our 25 ocular hypertensives (if a cutoff of 21 mmHg is used) were probably otherwise normal but labeled as ocular hypertensive because of a CCT-induced error in IOP.

The ocular hypertensives in this study were significantly younger than the other two groups, while the glaucoma cohort was the oldest (Mean age: normals- 45 years, glaucoma-50 years, ocular hypertensives-37.1 years)

Diagnosed glaucoma patients were included in this study if their IOP was stable and controlled with medications. This was done to avoid any physiological changes in CCT as a response to the widely fluctuating pressures known to occur in this population of patients. For the same reason, patients with angle closure glaucoma were excluded, as they are prone to intermittent closure with its attendant acute rise in IOP.

Our study thus confirms that CCT can be a confounding factor while recording IOP. A patient may be labeled an ocular hypertensive just because of the error in measuring his applanation IOP, leading to unnecessary prolonged treatment and/ or follow up.

CONCLUSION

Increased corneal thickness in ocular hypertension may lead to an overestimation of IOP.

This study confirms that a significant number of patients with ocular hypertension have normal IOPs after the appropriate adjustments have been made for deviations from normal in their central corneal thickness. In our study, 52 % of normal cases were misclassified as ocular hypertensives.

Determination of the CCT in OHT cases is crucial since it has great impact on IOP values, measured with applanation tonometer, which is the main parameter in the diagnosis and follow-up of glaucoma This will help prevent the erroneous labeling of normal patients as ocular hypertensives.

References

1. Ritch R, Shields MB, Krupin T. The Glaucomas
2. Duke-Elders S. System of Ophthalmology. St. Louis:1976.
3. Schmidt TAF. The clinical application of the Goldmann applanation tonometer. Am J Ophthalmol 1960; 49:967-78.
4. Ehlers N, Bramsen T, Sperling S. Applanation tonometry and central corneal thickness. Acta Ophthalmol 1975; 53:34-43.
5. Anderson DR, Pattela VM. Automated Static Perimetry. 2nd edition. St. Louis:C V Mosby, 1999.
6. Florey CDV. Sample size for beginners. Br Med J 1993
7. Ventura AC, Böhnke M, Mojon DS Central corneal thickness measurements in patients with normal tension,glaucoma, primary open angle glaucoma, pseudoexfoliation glaucoma, or ocular hypertension. Br J Ophthalmol. 2001 Jul;85(7):792-5.
8. Herndon LW, Choudhri SA, Cox T, Damji KF, Shields MB, Allingham RR.
Central corneal thickness in normal, glaucomatous, and ocular hypertensive eyes
Arch Ophthalmol. 1997 Sep;115(9):1137-41.
9. Yagci R, Eksioglu U, Midillioglu I, Yalvac I, Altiparmak E, Duman S.Central corneal thickness in primary open angle glaucoma, pseudoexfoliativeglaucoma, ocular hypertension, and normal population.Eur J Ophthalmol. 2005 May-Jun;15(3):324-8.
10. Copt RP, Thomas R, Mermoud A Corneal thickness in ocular hypertension, primary open-angle glaucoma, and normal tension glaucoma.Arch Ophthalmol. 1999 Jan;117(1):14-6.
11. Singh RP, Goldberg I, Graham SL, Sharma A, Mohsin M.Central corneal thickness, tonometry, and ocular dimensions in glaucoma and ocular hypertension.J Glaucoma. 2001 Jun;10(3):206-10.
12. Whitacre MM, Stein R: Sources of error with use of Goldmann-type tonometers. Surv Ophthalmol 1993, 38:1-30.
13. Doughty MJ, Zaman ML.Human corneal thickness and its impact on intraocular pressure measures: a review and meta analysis approach. Surv Ophthalmol 2000, 44(5):367-408.
14. Whitacre MM, Stein RA, Hassanein K: The effect of corneal thickness on applanation tonometry. Am J Ophthalmol 1993, 11:592-596.
15. Ehlers N, Bramsen T, Sperling S: Applanation tonometry and central corneal thickness. Acta Ophthalmol (Copen) 1975, 53:34-43.
16. Stodtmeister R: Applanation tonometry and correction according to corneal thickness. Acta Ophthalmol Scand 1998, 76:319-324.
17. Kass MA, Heuer DK, Higginbotham EJ, Johnson CA, Keltner JL, Miller JP, Parrish RK II, Wilson MR, Gordon MO: The Ocular Hypertension Treatment Study: a randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. Arch Ophthalmol 2002, 120:701-713.
18. Gordon MO, Beiser JA, Brandt JD, Heuer DK, Higginbotham EJ, Johnson CA, Keltner JL, Miller JP, Parrish RK II, Wilson MR, Kass MA: The Ocular Hypertension Treatment Study: baseline factors that predict

the onset of primary open-angle glaucoma. Arch Ophthalmology 2002, 120:714-720.

Author Information

Devdatta Deshmukh
Department of Ophthalmology, Armed Forces Hospital
Muscat, Oman

Rashid Al Saidi Al Saidi
Department of Ophthalmology, Armed Forces Hospital
Muscat, Oman

Abdulwakil Alugail
Department of Ophthalmology, Armed Forces Hospital
Muscat, Oman