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B. O. OSOTIMEHIN

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A. O. UWAIFO

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Use of limbal and central anterior chamber depth measurements in detecting eyes with gonioscopically occludable angles and primary angle closure glaucoma in Ibadan.

AO Ashaye

Department of Ophthalmology, University College Hospital, Ibadan, Nigeria

Summary

The routine use of gonioscopy for the evaluation of drainage angles in developing countries is not always done because of the busy clinics. The purpose of this study was to evaluate the performance of 2 tests: Peripheral Anterior Chamber Depth (PACD) measurement and Central Anterior Chamber Depth (CACD) measurement in detecting occludable angles and primary angle closure within subjects with primary glaucoma and control subjects. Two hundred and forty subjects with primary glaucoma and a control group of 250 subjects were studied. PACD was measured with the Van Herriek's method while CACD was measured by the technique described by Lowe. The findings were compared to the gonioscopic appearance of the drainage angles in the two groups. PACD gradings 0 to 2 correctly identified 28 out of 36 eyes (77.8%) of subjects with PACG who had gonioscopically closed angles. The test identified correctly 168 out of 204 eyes (82.4%) with gonioscopically open angles among subjects with primary glaucoma. Among subjects with no glaucoma, PACD gradings 0 to 2 correctly identified 12 out of the 14 eyes with gonioscopically occludable angles, while the test identified 238 eyes without occludable angles, gonioscopy identified 236 out of 250 of such eyes. A CACD less than 2.5mm was present in only 21 eyes of 36 eyes with occludable angles by gonioscopy among those with PACG. In the other 15 eyes with occludable angles, CACD was more than 2.5mm. PACD performed well in detecting occluded angles in this study, CACD was useful but less so than PACD in established cases of PACG. Subjects with PACG but whose CACD was 2.5mm or more may have plateau iris. PACD and CACD are both useful methods in identifying occludable angles in eyes of Nigerian subjects studied.

Keywords: Angle closure glaucoma, gonioscopy, limbal anterior chamber depth, central anterior chamber depth.

Résumé

L'utilisation routine de la gonioscopie pour l'évaluation l'angle de drainage chez les sujets dans la pays sous-développés n'est pas toujours faite dans les cliniques occupés. Le but de cette étude était pour évaluer la performance de 2 tests. La mesure de la profondeur de la chambre périphérique antérieure (PACD) et de la profondeur de la chambre centrale antérieure (CACD) pour détecter l'angle d'occlusion et la fermeture d'angle primaire aux sujets ayant le glaucome primaire et sujets de contrôle. Deux cent quarante sujets ayant le glaucome primaire et un groupe de contrôle de 250 sujets étaient étudiés. PACD étaient mesurés avec la méthode de Van Herriek lorsque le CACD était mesuré par la technique décrite par Lowe. Les données étaient comparés à l'apparence gonioscopique d'angle de drainage chez les 2 groupes. PACD gradé de 0 à 2 identifiait correctement 28

sur 36 yeux (77.8%) des sujets ayant le PACG qui avaient gonioscopiquement les angles fermés. Ce test identifiait correctement 168 sur 206 yeux (82.4%) ayant gonioscopiquement des angles ouvert parmi les sujets ayant le glaucome primaire. Parmi les sujets n'ayant pas de glaucome , le PACD gradé de 0 à 2 identifiait correctement 12 sur 14 yeux ayant gonioscopiquement d'angles occlusable ; la gonioscopie identifiait 236 sur 250 de tels yeux. Le CACD moins de 2.5mm était present chez 21 sur 36 yeux ayant d'angles occlusable par gonioscopie parmi ceux ayant le PACG. Dans d'autres 15 yeux ayant d'angle occlusable , le CACD était plus de 2.5mm. Le PACD détectait plus d'angles occlusable dans cette étude. Le CACD était utile mais moins que le PACD pour détecter les cas de PACG. Mais ceux ayant le CACD plus de 2.5mm avaient l'iris en plateau. LE PACD et PACG sont tous des méthodes utiles pour identifier les angles occlusales des yeux des sujets nigerian étudiés.

Introduction

Primary angle closure glaucoma (PACG) is not as rare as previously thought in Negroes [1]. Majority of cases were misdiagnosed because patients presented not with the well known acute congestive signs but with chronic symptoms similar to primary open angle glaucoma (POAG). Therefore, except gonioscopy is done the differentiation of PACG from POAG may be difficult in Negroes.

It is important for Ophthalmologist to identify a narrow angle capable of occlusion so that mydratics will not be used in such eyes to avoid the risk of precipitating an angle closure glaucoma. It is also invaluable for the eye doctor to be able to identify such subjects with angles capable of occlusion who may present with symptoms of intermittent angle closure. The doctor should be able to distinguish subjects with PACG from POAG, both of which present with chronic features but have to be managed differently.

Gonioscopy, the definitive way of assessing the characteristic of the drainage angles and identifying such eyes may not always be done in busy clinics as is always in developing countries. Studies have associated shallow anterior chamber with the development of primary angle closure glaucoma [2]. It has been found that anterior chamber depth less than 2.5mm increases the risk of angle closure glaucoma. Measurement of the central anterior chamber depth by optical pachymetry is used for research but is often not feasible as a routine test in busy eye clinics.

But the evaluation of the anterior chamber angle width by the van Herick's method [3] has been found to correlate well with gonioscopic classification of the angle in some studies [4-5] but not in others [6-8]. This procedure is particularly recommended as a tool to identify persons with angle closure glaucoma or persons with closeable angles and in populations with busy clinics this simple test has been valuable.

However, the diagnostic value of these test have not been examined in this environment. Therefore, the objective of this study is to evaluate the use of peripheral anterior chamber depth (PACD) measurement and central anterior chamber depth (CACD) measurement in detecting gonioscopically occludable

Correspondence: Dr. (Mrs.) A.O. Ashaye, Department of Ophthalmology, University College Hospital, Ibadan, Nigeria. Email: aashaye@seannet.com

angles among subjects with glaucoma and without, and identifying subjects with PACG among subjects with primary glaucoma.

Materials and methods

Consecutive newly diagnosed patients with adult primary glaucoma who presented to the outpatient department of the University College Hospital, Ibadan over a two year period (1996-98) and met the inclusion criteria were recruited into the study after an informed consent. A comparable group controls were recruited from the General Outpatients Department (G.O.P.D.) of the same hospital.

The diagnostic criteria for inclusion in the study were the presence of at least two of the followings; intraocular pressure 27mmHg or more, vertical cup to disc ratio of 0.5 or more and asymmetry of 0.2 or greater in the absence of other ocular diseases. Other cases of primary angle closure glaucoma must satisfy the following criteria, the occurrence of a sudden rise of intraocular pressure associated with shallow anterior chamber and corneal oedema preceded by symptoms of haloes and ocular pains. A structured record form was used to collect this information from these patients.

The visual acuity was measured with and without spectacles or pinhole with a standard Snellen chart at six metres. Estimation of temporal limbal chamber depth was done according to van Herick's method [3]. The slit lamp beam was placed almost perpendicular to the peripheral corneal surface in the temporal area and the angle opening was viewed at a 60 degree angle from the light beam. The width of the corneal section was compared to the distance between the cornea and the iris.

If the distance between the cornea and the iris (peripheral anterior chamber depth PACD) is equal to or greater than the corneal thickness, the peripheral anterior chamber angle was designated as grade 4. A peripheral anterior chamber depth one half of the corneal thickness constituted grade 3. Grade 2 depth occurred when the peripheral anterior chamber depth was equal to one fourth of the corneal thickness, while those eyes whose peripheral anterior chambers were less than one fourth of corneal thickness were classified as Grade 1. Grade 0 occurred when no distance occurred between the cornea and the iris.

The measurement of the central anterior chamber depth was done using the Haag-Streit pachymeter mounted on a slit lamp, according to the technique described by Lowe [9]. The distance between the corneal epithelium to the lens epithelium was measured twice and the average was recorded. An estimated value of 0.5mm was subtracted for corneal thickness in all subjects during data processing.

Intra-ocular pressure was measured with a Goldman applanation tonometer after a drop of amethocaine had been instilled into each eye. Fluorescein from a paper strip was used to stain the eye. Two consecutive readings were made, and an average of the two readings was taken. Gonioscopy was done using two mirror gonioscope ("Goldman", Model, Clement Clarke International) coupled with 2% hypomellulose fluid, examining 360 degree of the angle and classified as detailed below.

Tetracaine 0.5% (Alcon) was used for corneal anaesthesia. Examination was done with high magnification of the slit lamp microscope, observation was made at the four quadrants in the eye, with and without manipulation.

The width of the angle recess was graded by gonioscopy using the Scheie [10] system. An occludable angle was considered to be an angle in which the pigmented trabecular meshwork was not visible in three quarters of the circumference of the angle

without manipulation. For example, a width grade 2 in the presence of a convex iris preventing direct view of the trabecular meshwork except by manipulation and gaze changes was considered as occludable.

A closed angle was used to describe an angle of 0 or 1 even with manipulation. For the purpose of analysis peripheral anterior chamber depth PACD (Van Herick's method) grades zero to two were designated "shallow" and such subjects were hypothesized to have closed angle. PACD grades 3 and 4 were "deep" anterior chambers and therefore such eyes were expected to have open angle. The data was analysed using standard statistical methods for evaluating diagnostic tests. The sensitivity, specificity and positive predictive values were calculated.

Results

A total of 240 patients and 250 controls were recruited into this study. Patients with glaucoma were slightly older than their non-glaucoma patients but the difference was not statistically significant ($P > 0.05$, 57.8years SD = 11.5 versus 55.8years SD = 10.7). There was no statistically significant sex differential although an overall male preponderance was observed in both groups (Table 1).

Table 1: Age and sex distribution of glaucoma and non-glaucoma patients

Characteristics	Glaucoma		Non-glaucoma	
	n	%	n	%
Age groups				
30 - 39	14	5.8	18	7.2
40 - 49	47	19.6	53	21.2
50 - 59	60	25.0	65	25.0
60 - 69	83	34.6	82	32.8
70 and over	35	15.0	32	12.8
Total	240		250	
Sex				
Male	143	59.6	133	53.2
Female	97	40.4	117	46.8
Total	240		250	

Table 2: Usefulness of PACD in detection of gonioscopically closed angles

PACD	All gonioscopically closed	All gonioscopically opened	Total
"Shallow" grading 0-2	36	42	72
"Normal" grading 3-4	4	408	412
	40	450	490
Sensitivity	90.0%	(95% CI 59.8 - 99.6)	
Specificity	90.7%	(95% CI 82.7 - 94.4)	
+ Predictive value	47.8%	(95% CI 27.4 - 68.4)	
- Predictive value	99.1%	(95% CI 94.2 - 100)	

Table 2 shows the PACD gradings in eyes gonioscopically closed and open among all subjects studied. A high proportion of eyes (90%) with gonioscopically closed angles had PACD gradings zero to two designated shallow in this study.

PACD gradings zero to two were found in 42 eyes out of 450 gonioscopically open angles. This gives the sensitivity and

specificity of PACD estimation in predicting the presence of occluded angle to be 90.0% (95% CI 59.8 - 99.6) and 90.7% (95% CI 82.7 - 94.4) respectively. The positive predictive values of the test was 47.8% (95% CI 27.4 - 68.4) while the negative predictive value of the test was 99.1% (95% CI 94.2 - 100).

Among subjects with no glaucoma, gonioscopy identified 14 eyes (5.6%) with occludable angles. PACD gradings correctly identified 12 of such eyes (85.7%). The test identified 238 eyes who do not have occluded/occludable eyes whereas gonioscopy identified 236 of such eyes as not occludable (Table 3).

Table 3: Gonioscopic appearance and PACD in eyes with glaucoma and controls

Gonio width	Glaucoma		Non glaucoma		
	No. of eyes	%	No of eyes	%	
Closed	0	23	9.6	0	0
Open	1	13	5.4	4	1.6
	2	67	27.9	34	13.6
	3	124	51.7	152	
	4	13	5.4	60	
Total		240		250	
PACD					
‘Shallow’					
	0	3	1.3	0	0
	1	6	2.5	4	1.6
	2	57	23.8	8	3.2
Normal	3	99	41.2	158	63.2
	4	75	31.2	80	32.0
Total		240		250	

The PACD gradings was also able to identify 28 out of 6 eyes (77.8%) of subjects with PACG who had gonioscopically closed angles. For patients with gonioscopically open angles, the test identified correctly 168 out of 204 eyes (82.4%). The result presented in Table 4 indicated a low positive predictive value (17.8%) but a high negative predictive value (99.1%).

Table 4: PACD in subjects with PACG and POAG

PACD	PACG	POAG	Total
Shallow	28	38	66
Normal	8	168	174
	36	204	240
Sensitivity	77.8%	(95% CI 59.8% - 99.6%)	
Specificity	82.4%	(95% CI 80.7% - 94.4%)	
Positive Predictive value	47.8%	(95% CI 27.4% - 68.4%)	
Negative Predictive value	99.1%	(95% CI 94.2% - 100%)	

Table 5 shows the performance of central anterior chamber by optical pachymetry in the detection of occludable angle in subjects with no glaucoma and in those with established primary glaucoma. A CACD less than 2.5mm was used as a cut off for shallow anterior chamber. Of the 14 eyes with no glaucoma with occludable angle, CACD was less than 2.5mm in 13 of them. In the 236 eyes with no glaucoma and have angles not occludable, CACD less than 2.5mm was found in only 16 eyes and 220 eyes had CACD 2.5mm or more. The sensitivity of CACD in

identifying occludable angles in eyes without glaucoma was 92.9% while the specificity was 93.2%.

Table 5: The distribution of CACD < 2.5mm in eyes with gonioscopically occludable and non-occludable angles in eyes with glaucoma and without glaucoma

CACD < 2.5mm	No glaucoma		Primary glaucoma	
	Occludable angle Yes	Occludable angle No	Occludable Yes	Occludable No
Yes	13	16	21	8
No	1	220	15	196
Total	14	236	36	204
Sensitivity	92.9%		58.3%	
Specificity	93.2%		96.1%	

In 240 eyes with established primary glaucoma, 36 eyes had occludable angles and 21 eyes had CACD was less than 2.5mm. The proportion of eyes with CACD < 2.5mm was higher in eyes with occludable angles compared to non-occludable angle (58.3% versus 3.9%, $P < 0.001$). The sensitivity of CACD in identifying occludable angles in established glaucoma was 58.3% and this was statistically significantly less than 92.9% in subjects without glaucoma.

Discussions

The presence of shallow anterior chamber has been associated with closure of the drainage angle [2], yet routine measurement of chamber depth is not done, even when vital decisions have to be taken such as the avoidance of the use of mydratics in order to avoid precipitating angle closure glaucoma, or anterior chamber depth measurements in subjects who present with intermittent angle closure glaucoma.

Sometimes anterior chamber depth measurement is to distinguish between primary angle closure glaucoma and primary open angle glaucoma. The reason for not routinely measuring anterior chamber depth could be because the well known method, optical pachymetry is cumbersome and needs specialised equipments and training in its use. Yet it is imperative that an estimate of the anterior chamber depth be made. Central anterior chamber depth (CACD) measurement by optical pachymetry have been found in this study to have a high sensitivity and specificity (92.9%, 93.2% respectively) in identifying angles capable of occlusion in eyes without glaucoma. The cut off value of CACD less than 2.5mm used in this study has been found to be the level at which there is an increase in risk of development of acute angle closure glaucoma in other populations [2]. CACD measurement performed poorly in Olurin's study [11] presumably because both subjects with angle closure glaucoma and POAG were not differentiated or perhaps the cut off value of 2.5mm was not right for our population.

In this study, CACD measurement less than 2.5mm was only able to identify 58.3% of glaucoma subjects with angle closure identified by gonioscopy. Other eyes with PACG had CACD 2.5mm or more but peripheral anterior chamber measurement identified 28 out of 36 eyes with PACG (77.8%). Although CACD measurement identified occludable angles in non-glaucoma eyes with 92.9% sensitivity and 93.2% specificity, it was only able to identify a little above 50% of the eyes

with occluded angles in subjects with established PACG as found by Olurin [11]. Bearing in mind the possibility of differing measurement methods, these 2 studies in Nigeria within the same population suggest there may be a true difference in the anterior chamber configuration of subjects with PACG in this population. Perhaps eyes with CACD 2.5mm or more but shallow PACD are eyes with plateau iris. Alternatively the CACD value that poses a risk for angle closure glaucoma may be higher than the cut off value used in this study for this population.

Exploring the role of CACD measurement and PACD measurement in a community setting will give more decisive result. Peripheral anterior chamber depth measurement by the Van Herriek's method has been found to correlate well with gonioscopic classification in Caucasians [4]. Studies in Greenland, Taiwan and India [6-8] report fair to poor performance of the test. These are populations with a high prevalence of angle closure glaucoma.

A modified grading scheme of the Van Herriek's test was found to be an efficient screening method in Mongolia [5]. In that study sensitivity was 99% and specificity of the Van Herriek's test was 66%. The cut off value for PACD used in that study was 0 to 2 similar to the grades 0 to 2 used in this study.

Previous studies in Greenland, India and Taiwan [6-8] suggest the PACD test does not combine high sensitivity with high specificity. The current study found that PACD estimation is a good test in identifying gonioscopically occluded or occludable angles in all eyes examined, sensitivity was 90.0% and specificity was 90.7%, using gonioscopy as the gold standard.

Both examinations, gonioscopy and PACD measurements were performed by the same author on the same subjects eliminating the chancing of measurement variations. As a tool in distinguishing PACG from POAG, the sensitivity was 77.8% and the specificity was 82.4% using PACD gradings 0 to 2 to designate shallow chambers, hence occludable/occluded angles. PACD measurement performed better than CACD measurement by optical pachymetry in identifying eyes with PACG from eyes with POAG.

The CACD as a screening test may have the potential of performing well in eyes with no established disease i.e. community screening for potentially occludable angles, but the expensive equipment and training and time required may not justify its use. The PACD test may be useful in screening patients in the clinic to identify narrow angles, to avoid dilatation in such eyes, it is useful test in making a diagnosis of intermittent angle closure glaucoma and in clinics where there is no access to a gonioscope PACD help to distinguish POAG for PACG. PACD measurement may also be useful in identifying subjects with narrow angles who may later present with PACG, those who need to be further examined or receive prophylactic treatment.

Conclusion

CACD and PACD measurements are both sensitive methods in detecting occludable angles in Nigerian. Both tests are able to detect accurately established cases of PACG, the PACD performed better in the latter eyes. Those subjects with PACG who have CACD 2.5mm or more may have plateau iris.

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References

1. Buhmann R. R., Quiglas H.A, Barron Y., West S.K., Olivia M.S., Mbagu B.O.: Prevalence of Glaucoma in a Rural East African Population Invest Ophthalmol Vis Sci 2000; 41(1) 40-48.
2. Tornquist B.: Chamber Depth in Primary Acute Glaucoma. Br. J. Ophthalmol 1956; 40:421 - 429.
3. Van Herriek W., Shaffer R.N., Schwatz A.: Estimation of width of the angle of anterior chamber, incidence and significance of the narrow angle. Am J. Ophthalmol 1969; 68:626-629.
4. Vargas E., Drance S.M.: Anterior Chamber Depth in Angle Closure Glaucoma. Arch Ophthalmol 1973; 90:438-439.
5. Foster P.J., Devereux J.G., Alsbirk P.H., *et al*: Detection of gonioscopically occludable angles and primary angle closure glaucoma by estimation of limbal chamber depth in Asians: modified grading scheme. Br. J. Ophthalmol 2000; 84: 86-192.
6. Alsbirk P.H.: Limbal and axial chamber depth variations. A population study in Eskimos. Acta Ophthalmol 1986, 64: 593-600.
7. Thomas R, George T, Braganza A, *et al*: The flashlight test and Van Herriek's test are poor predictors for occludable angles. Aust N Z J Ophthalmol 1996; 24: 251-256.
8. Congdon N, Quigley H.A., Hing P.T. *et al*: Screening techniques for angle closure glaucoma in rural Taiwan. Acta Ophthalmol 1996; 74: 113-119.
9. Lowe R.F.: New instruments for measuring anterior chamber depth and corneal thickness. Am J. Ophthalmol 1966; 58:510-512.
10. Schere H.: Width and pigmentation of the angle of the anterior chamber. A system of grading by gonioscopy Arch Ophthalmol 1957; 58: 510-512.
11. Olurin O.: Anterior chamber depth of Nigerians Ann Ophthalmol 1977; 9:315-326.