

Alteration of anterior chamber in 81 glaucomatous eyes using Pentacam Scheimpflug system

Xuan Zou, Xuan-Chu Duan, Qian Zhong

Department of Ophthalmology, the Second Xiangya Hospital, Central South University, Changsha 410011, Hunan Province, China

Correspondence to: Xuan-Chu Duan. Department of Ophthalmology, the Second Xiangya Hospital, Central South University, Changsha 410011, Hunan Province, China. duanxchu@yahoo.com.cn

Received:2010-10-09 Accepted:2010-11-18

Abstract

- **AIM:** To study the effects of gender, eye side and age on anterior chamber measurements; To compare the anterior chamber parameters between glaucoma and normal subjects.
 - **METHODS:** A total of 169 patients (299 eyes), of which 122 normal subjects (218 eyes), 24 cases (39 eyes) with primary angle-closure glaucoma (PACG) and 22 cases (42 eyes) with primary open-angle glaucoma (POAG) visiting our hospital from Apr. 2008 to Oct. 2008 were enrolled. The parameters measured by Pentacam between different sexes, eye sides, ages and different groups were compared.
 - **RESULTS:** The mean central anterior chamber depth (CACD), anterior chamber volume (ACV) and anterior chamber angle (ACA) measurements of normal eyes were 2.82 ± 0.43 mm, 159.74 ± 43.64 mm³ and $35.47 \pm 7.92^\circ$. There were no significant differences between different eye sides. There was a negative correlation between age and anterior chamber parameters (all $P < 0.001$); The mean CACD, ACV and ACA were 1.87 ± 0.29 mm, 82.00 ± 24.17 mm³ and $21.94 \pm 7.11^\circ$ in PACG group, and 2.67 ± 0.34 mm, 147.24 ± 43.40 mm³ and $31.19 \pm 6.34^\circ$ in POAG group. The differences between PACG and age-matched normal subjects were significant (all $P < 0.05$), but there was no significant difference between POAG and age-matched normal subjects ($P > 0.05$).
 - **CONCLUSION:** CACD, ACV and ACA decrease mildly with age. Anterior chamber parameters of PACG are smaller than that of normal eyes, but there is no difference between POAG and normal eyes.
 - **KEYWORDS:** central anterior chamber depth; anterior chamber volume; anterior chamber angle; Pentacam Scheimpflug system; glaucoma
- DOI:10.3980/j.issn.2222-3959.2010.04.17

Zou X, Duan XC, Zhong Q. Alteration of anterior chamber in 81 glaucomatous eyes using Pentacam Scheimpflug system. *Int J Ophthalmol* 2010;3(4):349-351

INTRODUCTION

Primary angle closure glaucoma (PACG) is highly prevalent in the Asian populations^[1]. Assessing of the anterior chamber depth (ACD), anterior chamber volume (ACV) and anterior chamber angle (ACA) are very important in the diagnosis of primary angle-closure glaucoma (PACG). Currently, gonioscopy is still the gold standard for identifying occludable angles. However, it is a subjective technique requiring skills and could be uncomfortable for patients. UBM is accurate on the measurement of anterior chamber angle, but it could be poorly tolerated for contacting patients' eyes. The Pentacam images the anterior segment of the eye by a rotating Scheimpflug camera measurement, which has recently become available. This rotating process supplies three-dimensional pictures. The measurement process lasts less than two seconds and minute eye movements that are captured and corrected simultaneously. It promises to overcome some limitations of the gonioscopy and UBM, and may be excellent candidates for assessment of angle structure. In our study, we measured the anterior chamber parameters of normal subjects and patients with PACG or primary open-angle glaucoma (POAG) by Pentacam, and compared the parameters between different groups.

MATERIALS AND METHODS

Materials A total of 168 patients (299 eyes) were enrolled in this study. Among the subjects, 122 (218 eyes) had normal eyes, 24 (39 eyes) had PACG, and 22 (42 eyes) had POAG. One hundred and twenty-two patients were recruited for the study that represented a normal group of patients who visited the clinic from Apr. 2008 to Oct. 2008. The exclusion conditions included corneal diseases, such as corneal edema, corneal scarring; iridocyclitis; history of ocular trauma or intraocular surgery; recent history of corneal contact lens obvious opacity of lens in the pupil area; unable to fix and local or general use of corticosteroid. All the 46 glaucoma patients in the study had a recent glaucoma evaluation at our

Table 1 Anterior chamber parameters and age in normal people

Age group(yr)	n	CACD(mm)	ACV(mm ³)	ACA(°)
1 (11-)	27	3.1±0.3	183.0±33.5	36.7±1.6
2 (21-)	71	3.1±0.3	190.8±31.8	38.3±0.7
3 (31-)	22	2.7±0.4	151.0±37.5	32.4±1.5
4 (41-)	25	2.7±0.4	148.96±35.31	33.22±1.69
5 (51-)	44	2.5±0.3	126.86±34.73	32.08±1.04
6 (61-)	29	2.5±0.3	127.97±36.62	34.01±1.63

clinic in Changsha, Hunan Province. Glaucoma diagnosis and severity were based on specialists' consensus on the diagnosis and treatment for primary glaucoma in China, which was made by glaucoma group of Chinese Medical Association and the Committee of Chinese Journal of Ophthalmology in May 2008. The diagnosis of PACG is established when elevated intraocular pressure is associated with angle closure, with or without glaucomatous optic disk or field changes. According to the clinical manifestation, it can be classified as acute and chronic angle closure glaucoma. The diagnosis of POAG is established when glaucomatous optic disk or field changes are associated with elevated intraocular pressures (usually >21mmHg by Goldmann tonometer), a normal-appearing open anterior chamber angle, and no other reasons for intraocular pressure elevation. The mean age for the 122 normal patients was 39.5±17.2 years, ranging from 13 to 80 years. In 24 patients with PACG, the mean age was 60.0±9.6 years, ranging from 32 to 74 years. In 22 patients with POAG, the mean age was 49.0±17.6 years, ranging from 21 to 86 years. Patients with PACG or POAG were significantly older than those with normal eyes (both $P<0.05$). Women comprised of 51% of normal patients, 54% of PACG and 50% of POAG.

Methods The Pentacam imaged the anterior eye with a rotating Scheimpflug camera, and it performs up to 50 scans, with each scan having 500 images, for totally 25000 true data points (measurement and elevation points). The instrument analyzed the anterior chamber by calculating chamber angle, volume, height, and diameter at any location. The Pentacam determined central anterior chamber depth (CACD) by measuring the distance from the endothelium at the corneal apex to the anterior lens capsule. Measuring angle width with Pentacam required the user to place up to ten marks on the cornea endothelium to determine the plane of curvature, and to place a line along the iris to identify the angle at which it was directed. ACV was calculated automatically by Pentacam after the rotating scan.

Statistical Analysis The SPSS 16.0 for Windows system was used for statistical analysis. Sample characteristics were analyzed using mean±standard deviation (quantitative data). To compare CACD, ACV and ACA differences between glaucoma and normal eyes t -test was used. Spearman

correlation was used to analyze the relationship between age and anterior chamber parameters. Regression models for potential predictors of CACD and ACV measurements included age. $P<0.05$ was considered statistically significant.

RESULTS

Gender eye side and age The mean CACD in 122 normal subjects (218 eyes) was 2.8±0.4mm, ranging from 1.8 to 4.0mm. CACD accorded with normal distribution ($u_{gl}=0.74$ (Skewness), $u_{g2}=1.79$ (Kurtosis), both $<u_{0.05}=1.96$, $P>0.05$). The mean ACV in normal subjects was 159.7±43.6mm³, ranging from 62.0 to 262.0mm³, and ACV accorded with the normal distribution too ($u_{gl}=0.82$ (Skewness), $u_{g2}=1.48$ (Kurtosis), both $<u_{0.05}=1.96$, $P>0.05$). The mean ACA in normal subjects was 35.5±7.9°, ranging from 9.8 to 60.9°, and ACA did not accord with normal distribution ($u_{gl}=1.70$ (Skewness), $u_{g2}=2.4$ (Kurtosis) $>u_{0.05}=1.97$, $P<0.05$). Women with normal eyes had lower mean CACD(2.8±0.4mm), ACV (158.1±44.6mm³) and ACA (35.1±7.1°) than men (2.8±0.4mm, $P_{CACD}=0.300$; 161.3±42.8mm³, $P_{ACV}=0.58$; 35.8±8.7°, $P_{ACA}=0.467$), but the difference was not statistically significant. Totally 112 right eyes comprised of 51% of the 218 normal eyes. Right normal eyes had similar mean CACD (2.8±0.4mm), ACV (160.1±42.6mm³) and ACA (35.7±7.9°) with left eyes (2.8±0.4mm, $P_{CACD}=0.713$; 159.3±44.9mm³, $P_{ACV}=0.889$; 35.2±8.0°, $P_{ACA}=0.636$), and the difference was not statistically significant. In normal eyes, age was significantly correlated with CACD ($r=-0.629$, $P<0.01$),ACV ($r=-0.605$, $P<0.01$) and ACA ($r=-0.359$, $P<0.001$). With each additional year of aging, CACD was decreased by an average of 0.015mm, and ACV was decreased by an average of 1.51mm³ (Table 1). The linear regression equations of CACD and ACV to age were $Y_{CACD}=3.433-0.015 X(\text{age})$ and $Y_{ACV}=219.596-1.514 X(\text{age})$.

Anterior chamber in glaucoma In order to exclude the effect of age on anterior chamber parameter measurements, we chose 24 normal subjects who matched the PACG group and other 22 normal subjects who matched the POAG group. The mean age of adjusted normal subjects for PACG was 60.0±9.6 years, and women comprised of 54%. The mean age of adjusted normal subjects for PACG was 49.0±17.6 years, and women comprised of 50%.

The mean CACD (1.9±0.3mm), ACV (82.0±24.2mm³) and

ACA ($21.9 \pm 7.1^\circ$) in 24 patients with PACG were significantly less than those in normal subjects ($v_s 2.5 \pm 0.4\text{mm}$, $130.1 \pm 41.2\text{mm}^3$, $32.7 \pm 8.6^\circ$; $P < 0.05$). But the mean CACD (2.7 ± 0.3 $v_s 2.7 \pm 0.3\text{mm}$), ACV (147.2 ± 43.4 $v_s 147.9 \pm 35.1\text{mm}^3$) and ACA ($31.2 \pm 6.3^\circ$ $v_s 32.6 \pm 7.3$) in POAG were similar with normal subjects (all $P > 0.05$).

DISCUSSION

In our study, we measured the anterior chamber parameters of normal subjects and patients with glaucoma by Pentacam. The Pentacam is capable of calculating CACD from the corneal endothelium (posterior) or from the corneal epithelium (anterior)^[2]. We chose our measurements from the posterior surface. This would allow a more accurate comparison of our data with existing work in the literature. Rabsilber *et al*^[3] reported the mean CACD of 76 normal patients as $2.9 \pm 0.4\text{mm}$, ACV as $160.3 \pm 36.8\text{mm}^3$, and ACA as $34.8 \pm 5.0^\circ$ measured with the Pentacam. We had the similar results: the mean CACD in 122 normal subjects was $2.8 \pm 0.4\text{mm}$, ACV was $159.7 \pm 43.6\text{mm}^3$, and ACA was $35.5 \pm 7.9^\circ$.

Normal women in our study has a lower mean anterior chamber parameters than men, but not statistically significant. While most other studies show that women had shallower CACD and narrower ACA^[4-6], So women are more likely to have PACG^[7]. Besides, the eye side does not affect the anterior chamber parameters. Based on our analysis, age is a significant factor attributing to anterior chamber parameters. Such an observation is consistent with many reports in the literature that as the human lens grows throughout life; the globe does not, resulting in lens thickening which causes the shallow of CACD and narrow of ACA with aging^[8,9]. Therefore, aging is an important risk factor for angle-closure glaucoma.

PACG is diagnosed in cases with an occludable angle combined with or without glaucomatous optic neuropathy and consistent visual morbidity. In our study, we found that anterior chamber parameters of PACG were smaller than that of normal eyes obviously. Therefore, early screening of anatomical change of anterior chamber is important for the high prevalence of PACG in certain regions. The results

indicate that general anatomy and morphology of POAG are similar to normal eyes. It is because that the chief pathologic feature of POAG is a degenerative process in the trabecular meshwork, including deposition of extracellular material within the meshwork and beneath the endothelial lining of Schlemm's canal. The consequence is a reduction in aqueous drainage leading to a rise in intraocular pressure.

In conclusion, anterior chamber imaging has advanced greatly over recent years, and Pentacam is one of the new techniques, which may provide good images and quantitative data about the anterior chamber including CACD, ACV and ACA. However, there are still some major limitations and a lack of standardization between instruments. By Scheimpflug photography, CACD, ACV and ACA decrease mildly with age in normal subjects. The three anterior chamber parameters of PACG are smaller than that of normal eyes obviously, but there is no difference between POAG and normal eyes.

REFERENCES

- 1 Foster PJ, Johnson GJ. Glaucoma in China—how big is the problem? *Br J Ophthalmol* 2001;85(11):1271-1272
- 2 Belin MW, Khachikian SS, Ambrósio R Jr, Salomão MQ. Keratoconus/ectasia detection with the oculus pentacam: Belin/Ambrosio Enhanced Ectasia Display. *Highlights Ophthalmol* 2007;35(6):5-12
- 3 Rabsilber TM, Khoramnia R, Auffarth GU. Anterior chamber measurements using Pentacam rotating Scheimpflug camera. *J Cataract Refract Surg* 2006;32(3):456-459
- 4 Xu L, Cao WF, Wang YX, Chen CX, Jonas JB. Anterior chamber depth and chamber angle and their associations with ocular and general parameters: the Beijing Eye Study. *Am J Ophthalmol* 2008;145(5):929-936
- 5 Warrier S, Wu HM, Newland HS, Muecke J, Selva D, Aung T, Casson RJ. Ocular biometry and determinants of refractive error in rural Myanmar: the Meiktila Eye Study. *Br J Ophthalmol* 2008;92(12):1591-1954
- 6 He M, Huang W, Zheng Y, Alsbirk PH, Foster PJ. Anterior chamber depth in elderly Chinese: the Liwan eye study. *Ophthalmology* 2008;115(8):1286-1290
- 7 Kamo J, Saso M, Tsuruta M, Sumino K, Kashiwagi K. Aging effect on peripheral anterior chamber depth in male and female subjects investigated by scanning peripheral anterior chamber depth analyzer. *Nippon Ganka Gakkai Zasshi* 2007;111(7):518-525
- 8 Koretz JF, Kaufman PL, Neider MW, Goeckner PA. Accommodation and presbyopia in the human eye—aging of the anterior segment. *Vision Res* 1989;29(12):1685-1692
- 9 Zadnik K, Mutti DO, Fusaro RE, Adams AJ. Longitudinal evidence of crystalline lens thinning in children. *Invest Ophthalmol Vis Sci* 1995;36(8):1581-1587