Original Article

Relationship between the Alignment of a Non-Mydriatic Fundus Camera, Anterior Chamber Depth and Axial Length

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Abstract

Purpose: To evaluate the relationship between the position of the focal adjustment knob of a fundus camera and refractive error and biometric data as measured in the same eye.

Methods: Normal eyes of patients presenting to clinics at the Beijing Tongren Hospital were examined with a non-mydriatic fundus camera. The position on the focal scale of a knob adjusting the distance between the camera lens and film plane, used to adjust focus the image of the patients fundus relative to the refractive power of the eye, was recorded in degrees. Ocular biometry and refractometry were performed on the same eyes.

Results: The study included 136 subjects with a mean age of 36.5±19.6 years and a mean refractive error of −1.31±2.77 diopters. In univariate analysis, the position of the adjustment knob was significantly associated with refractive error ($P<0.001$; correlation coefficient $r=-0.77$), axial length ($P<0.001$; $r=0.65$) and anterior chamber depth ($P<0.001$; $r=0.48$). After adjustment for age, anterior chamber depth decreased by 0.01 mm (95% confidence interval: 0.003, 0.017) for change per degree in the position of the adjustment knob.

Conclusion: A fundus camera can be used to estimate anterior chamber depth, axial length and refractive error. In a screening setting, a fundus camera operated by a technician may be helpful to detect a shallow anterior chamber and evaluate a potential risk factor for primary angle closure. (***Eye Science 2012; 27:30-33***)

Keywords: angle-closure glaucoma; fundus camera; anterior chamber depth; hyperopia

The optical design of a fundus camera is similar to that of an indirect ophthalmoscope[1,2]. A light source within the camera illuminates the retina. The illuminated retinal structures are projected through the pupil of the eye and through the front lens of the camera, in which an image is formed. This aerial image in the camera is focused onto the film plane of the camera by adjusting the distance between the objective of the camera and the film plane[3]. The adjustment of the distance between the camera objective and the film plane to focus the image is achieved by turning a knob located on the side of the camera (Figure 1). The appropriate distance between the camera objective and the film plane depends on the optical properties of the eye, including its refractive error and the biometric measurements such as anterior chamber depth and axial length[3]. The present study tests the hypothesis that using a non-mydriatic fundus camera and assessing the position of the knob for focusing the image can be a useful approximate assessment of the refractive error of the eye and of its biometric parameters.

Materials and methods

The clinical observational hospital-based study included subjects attending the Beijing Tongren Hospital. Exclusion criteria were any operation potential ly effecting the refraction of the globe, clinically significant cataracts, or any fundus disease, glaucoma, or inability to cooperate with the examiner. High myopia was not an exclusion criterion, unless there was myopic retinopathy.

The verbal consent of each participant was obtained before examination. Approval for the study was obtained from the Ethics Committee, Beijing Tongren Hospital, Capital Medical University. The

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project adhered to the Declaration of Helsinki.

All the study participants underwent an ophthalmological examination, including subjective and objective refractometry, using an auto-refractometer (RM-A7000, Topcon Ltd., Tokyo, Japan), ocular biometry (Lenstar Biometry; LS900, Haag-Streit, Berne, Switzerland), slit lamp assisted biomicroscopy of the anterior segment of the eye, ophthalmoscopy, and 45° fundus photography using a non-mydriatic digital fundus camera (CR-DGI camera, Canon Inc, Tokyo, Japan) without pupil dilation in a dark examination room. All fundus images were obtained by one of two trained and supervised technicians. The spherical equivalent was calculated as sphere plus half cylinder and expressed in diopters.

At the side of the camera, a scale was adjusted to the knob, which regulated the distance between the camera objective and the film plane (Figure 1). Using the scale, the turning position of the knob could be measured in degrees (Figure 1). The position of the knob appropriate for a sharp fundus photograph of an emmetropic eye was defined as zero position. Depending on the refractive error of the examined eye, the knob was adjusted in a clockwise direction or a counterclockwise direction. For the examination with the fundus camera, the room was darkened so that only the monitor shed some light. The camera was positioned in front of the eye and was aligned to obtain a fundus photograph centered onto the macula.

Figure 1 Photograph of the adjustment knob at the site of the fundus camera

Statistical analysis

Statistical analysis was performed using a commercially available statistical software package (SPSS for Windows, Version 19.0, SPSS, Chicago, IL). Data were presented as mean ±standard deviation. The relationship among the parameters was assessed using Pearson's correlation coefficient. $P<0.05$ was considered to indicate a statistically significant result. A 95% confidence interval (CI) was given. The data of only one eye per subject were included in the statistical analysis.

Results

The study included 136 subjects (52 men) with a mean age of 36.5±19.6 years (range: 7 to 79 years) and a mean refractive error of −1.31±2.77 diopters (range: −8.7 diopters to +4.3 diopters). The mean axial length was 23.95±1.32 mm (range: 21.37 mm −27.90 mm), and the mean anterior chamber depth 2.83±0.49 mm (range: 1.52 mm−3.78 mm). The mean position of the knob was 0.70 ± 10.9° (−21° to +33°).

In univariate analysis, the position of the adjustment knob was significantly associated with refractive error ($P<0.001$; correlation coefficient $r=-0.77$) (Figure 2), axial length ($P<0.001$; $r=0.65$) (Figure. 3), and anterior chamber depth ($P<0.001$; $r=0.48$) (Figure 4). Additionally, the position of the adjustment knob was correlated with age ($P<0.001$; $r=-0.50$). The associations between the position of the adjustment knob of the fundus camera and the anterior chamber depth, axial length, and refractive error remained statistically significantly valid if the study population was divided into a younger group (aged<50 years) and an older group (aged>50 years).

In multivariate analysis, regarding anterior chamber depth as a dependent parameter and age and position of the adjustment knob as independent parameters, anterior chamber depth was significantly associated with age ($P<0.001$; regression coefficient b: -0.013 (95% CI: −0.017, −0.009) and the position of the adjustment knob ($P=0.005$; regression coefficient b: 0.010 (95% CI: 0.003, 0.017).

Discussion

The present study suggests that utilizing the position of the adjustment knob to focus the ocular fundus image in a fundus camera can help estimate the refractive error and biometric measures of the eye,

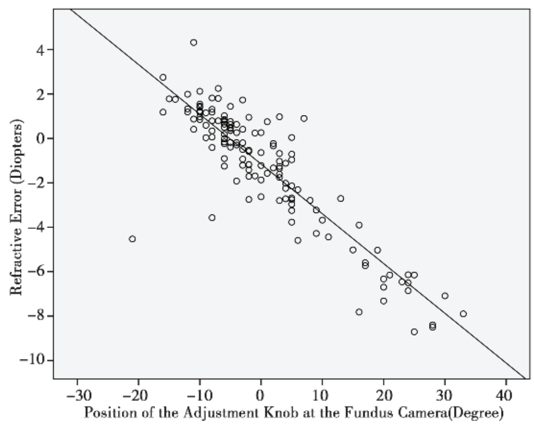

Figure 2 Scattergram showing the correlation between the position of the adjustment knob for focusing of the fundus image in the fundus camera and the refractive error of the examined eye (P<0.001; correlation coefficient r=–0.77); Refractive Error (Diopters) =–0.22 x Position of the adjustment knob of the fundus camera (Degree)−1.16.

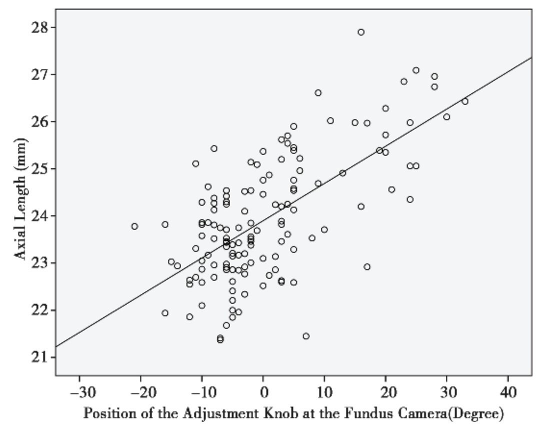

Figure 3 Scattergram showing the correlation between the position of the adjustment knob for focusing of the fundus image in the fundus camera and the axial length of the examined eye (P<0.001; correlation coefficient r= 0.65); Axial Length (mm) =0.08 x Position of the adjustment knob of the fundus camera (Degree) +23.90.

such as anterior chamber depth and axial length. After adjustment for age, anterior chamber depth decreased by 0.01 mm (95% confidence interval: 0.003, 0.017) for each degree change in the position of the adjustment knob. This result appears plausible due to the construction and optical plan of a fundus camera[2,3].

The results of our study agree with previous findings. Michael et al. assessed the position of the adjustment knob of three different fundus cameras (TRC-50F and TRC-50X; Topcon America Corp, Paramus, NJ; and the CR6-45NM Non-mydriatic Retinal Camera; Canon Inc, Tokyo, Japan) when taking photographs of optic nerve head, and found a significant correlation with the refractive error of the subjects[4].

As is well-known, the anterior chamber can be measured by gonioscopy, ultrasound biomicroscope (UBM), or anterior segment optical coherence tomography (AS-OCT)[5,6]. However, it is not realistic to be used for detection in the community because of safety issues and long duration. The result of our study may have a practical significance. If in a screening setting, a non-mydriatic fundus camera is used to obtain images of the fundus to detect retinal diseases such as diabetic retinopathy[7–9] and age-related macular degeneration[10], or to detect optic nerve diseases such as glaucoma[11,12]. The position of the adjustment knob to focus the fundus images may be taken to get a rough estimate of the anterior chamber depth. The method is better than oblique flashlight test, in which the results are subjective and cannot be recorded. Since the depth of the anterior chamber strongly correlates with the risk of developing primary angle closure glaucoma[13–15], the information additionally supplied by the fundus camera examination may help detect the subjects with the risk of primary angle closure glaucoma[16].

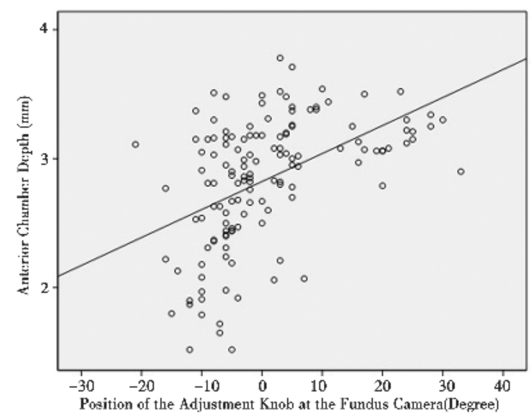

Figure 4 Scattergram showing the correlation between the position of the adjustment knob for focusing of the fundus image in the fundus camera and the anterior chamber depth of the examined eye (P<0.001; correlation coefficient r=0.48); Anterior Chamber Depth (mm) =0.022 x Position of the adjustment knob of the fundus camera (Degree) +2.82.

Limitations of the present study should be mentioned. First, the study participants did not undergo gonioscopy to examine the narrowness of the anterior chamber angle; thus, the results may lead only to the conclusion that the anterior chamber depth can roughly be estimated with the assistance of a fundus camera. Second, refractometry and the fundus examination were not performed in cycloplegia. The associations between the position of the adjustment knob of the fundus camera and the anterior chamber depth or the axial length remained valid, however, if the study population was divided into a younger group with an age of less than 50 years, and an older group aged above 50 years. Third, the correlation between the position of the adjustment knob of the fundus camera with axial length was stronger than that with anterior chamber depth (Figures. 3 and 4). The latter correlation showed some scattering pattern (Figure.4), so that the diagnostic precision of using the fundus camera to estimate the anterior chamber depth was relatively limited. The present authors intend to evaluate this measurement compared with gonioiscopy, UBM, or AS-OCT in a future study.

In conclusion, using a fundus camera can give an estimate of the anterior chamber depth, axial length, and refractive error. If used in a screening setting, a fundus camera operated by a technician may be helpful to detect a shallow anterior chamber, and thus find a potential risk for primary angle closure.

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