

The Use of the Non-Mydriatic Fundus Camera in Glaucoma Evaluation

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Abstract

Objective: To evaluate the use of the non-mydriatric fundus camera in evaluation of optic nerve head vertical cup to disc ratio in glaucoma patients.

Design: Cross-sectional descriptive comparative study

Material and Method: Indirect ophthalmoscopy with 78 diopter lens and a digital non-mydriatric fundus camera were performed in forty two subjects (23 normal controls and 19 glaucoma). The estimated vertical cup to disc ratio (VCDR) from both methods were analyzed. The effect of the pupillary dilation on the estimation of VCDR from non-mydriatric fundus camera was also determined.

Result: The mean ophthalmoscopically estimated VCDR was (mean \pm SD) 0.479 ± 0.18 , compared with a VCDR of (mean \pm SD) 0.462 ± 0.18 , measured with the non-mydriatric fundus camera (difference 0.017; 95% confidence interval [CI], 0.005–0.028; $p=0.007$). The overall correlation between the non-mydriatric fundus camera and indirect ophthalmoscopy with 78 D lens is 0.895 ($p<0.001$). From the receiver operating curve (ROC) at 90% specificity, the estimated VCDR from the non-mydriatric fundus camera yielded 68.4% sensitivity.

Conclusion: The non-mydriatric fundus camera provided good correlation with minimal difference in the estimated VCDR, when compared with the standard indirect ophthalmoscopy with a 78 D lens. In conjunction with IOP measurement, a non-mydriatric fundus camera can make a useful tool for glaucoma screening.

Introduction

As we have long known, screening for glaucoma is one of the important approaches to prevent blindness from this sight threatening disease. Careful examination of the optic nerve head and measurement of intraocular pressure are essential for screening glaucoma. Digital imaging systems that can provide rapid, magnified and realistic 3-dimensional optic nerve head images without the need of mydriasis are of great benefit for mass screening programs. While we are still waiting for better instruments, time-consuming conventional examination with pupillary dilation and optic nerve head ophthalmoscopy are mandatory.

The use of the non-mydratric fundus camera, using polaroid film to capture the image, was first launched in 1985 for diabetic retinopathy screening¹. Later, the instant digital imaging system replaced the traditional polaroid photography as it is faster, easier and more cost-effective². Several studies showed good sensitivity and specificity detection of retinopathy and other retinal disorders^{2,3,4,5}. One of the advantages is that this is a non-invasive technique. Images can be obtained through pupils as small as 3.7 millimetres; therefore, no pupillary dilation is required. It provides 30 to 45 degrees of posterior pole (angle of coverage) with a resolution of 3.1 mega-pixels. Magnification of the area in question can be achieved. Data from different retinal areas can be obtained easily by asking the patients to look at the different directions until the area concerned is clearly visible. By this means, the appearance of the optic nerve head can also be appreciated in magnified, 2-dimensional (monoscopic) and in true-color images.

Reliable assessment of the vertical cup to disc ratio (VCDR) is essential for the diagnosis of glaucoma^{6,7}. Using ophthalmoscopy VCDR, glaucoma could be correctly identified in 90% of patients^{8,9}. Stereoscopic methods of photographic optic disc assessment are considered to be better than monoscopic methods¹¹. But only scant data, regarding the usefulness of the non-mydratric fundus camera in glaucoma screening are available^{12,13,14}. Therefore, this study aims to evaluate the correlation between the non-mydratric fundus camera and standard ophthalmoscopy for estimation of VCDR in normal and glaucoma patients. In addition, the difference of VCDR estimation of the non-mydratric fundus camera, when in use with and without pupillary dilation, is also determined.

Methods

Forty-two eyes from 42 subjects (23 normal controls and 19 glaucoma patients) underwent ophthalmic examination by one general ophthalmologist (NL). In the glaucoma group, all patients had glaucomatous optic neuropathy with confirmed glaucomatous visual field defect. Patients with previous intraocular surgery were excluded from the study. Normal subjects were the patients who visited our clinic for routine eye check-up. Abnormal eye examination other than refractive error and senile change in lens clarity could preclude subjects from further study. All subjects underwent thorough examinations including measurement of best corrected visual acuity, intraocular pressure, anterior segment examination and dilated fundus examination. The optic nerve heads

were carefully examined with a 78 diopter lens. Optic nerve head photographs were taken by a non-mydriatic fundus camera (Topcon TRC NW200) both before and after mydriasis (used 1% Tropicamide 1–2 drop to studied eye). At least 5–millimeters of pupillary diameter is required after dilation. Only good quality images were used for analysis. Optic cup was defined based on its contour following the course of small blood vessels on the disc and not on the pallor. Vertical cup to disc ratio (VCDR) measurement from the non-mydriatic fundus camera (with and without dilation) and from 78 diopter indirect ophthalmoscopy were analyzed. This study has been approved by the Medical Ethics Committee of Thammasat University with written informed consent.

Data Analysis

From each patient we selected one eye with better non-mydriatic fundus image quality for analysis. The means of estimated VCDR from indirect ophthalmoscopy and the non-mydriatic fundus camera were compared with student’s *t* test. Correlations of VCDR from two tests (non-mydriatic fundus camera and 78 D) were calculated with the Pearson correlation coefficient. The means of estimated VCDR, with and without dilation from both tests, were compared with one way ANOVA. The areas under the receiver operating curve (ROC) were used to determine the diagnostic value of the non-mydriatic fundus camera (using solely VCDR). Statistic analyses were calculated with the SPSS program (version 11.5)

Results

Table 1 Demographic data of studied group (normal and glaucoma) and mean estimated VCDR obtained from indirect ophthalmoscopy with 78–diopter lens and non-mydriatic fundus camera (with and without dilation of the pupil)

	Normal	Glaucoma	<i>p</i>
Number of patients	23	19	
Age	54.74 (14.7)	63.89 (12.3)	
BCVA (Decimal)	0.66 (0.2)	0.41 (0.2)	
IOP	15.13 (2.1)	16.95 (4.3)	
VCDR (mm.)			
78 D	0.4 (0.1)	0.69 (0.2)	<0.01
NM1	0.35 (0.1)	0.60 (0.2)	<0.01
NM2	0.37 (0.1)	0.62 (0.2)	<0.01

Data were shown in mean (SD)

BCVA: Best corrected visual acuity

IOP: Intraocular pressure

VCDR: Vertical cup to disc ratio

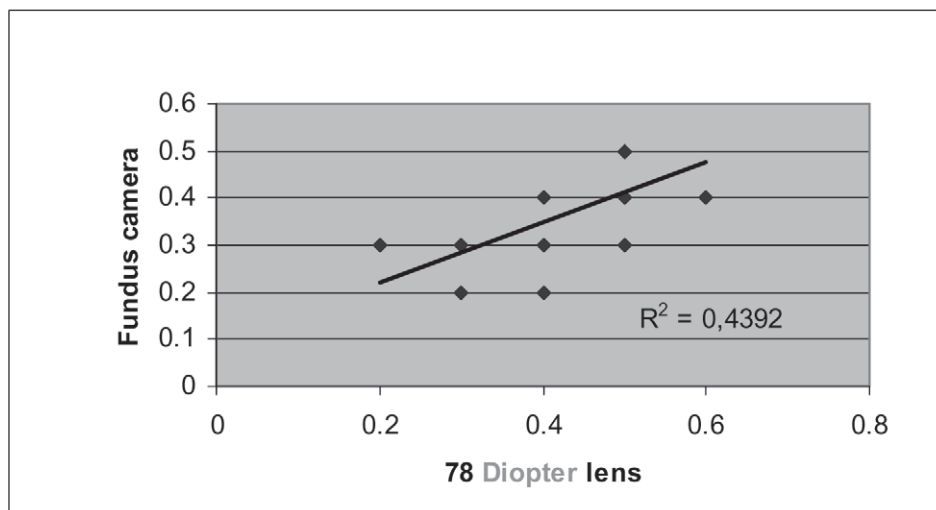
NM1: Non-mydriatic fundus camera before dilation of pupil

NM2: Non-mydriatic fundus camera after dilation of pupil

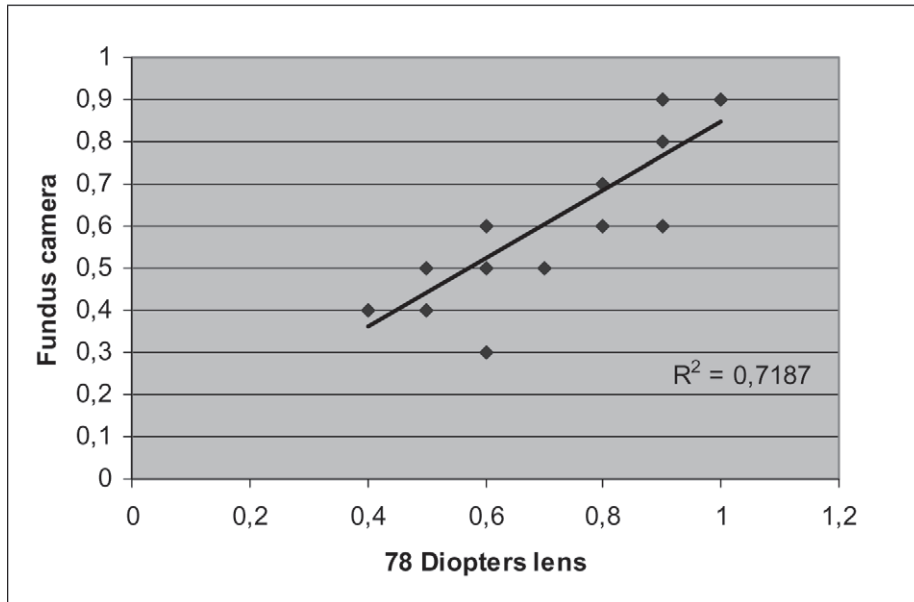
Table 1 shows the demographic data and VCDR of normal and glaucoma patients. The means estimated VCDR from all 3 methods were significantly larger in the glaucoma group than in the normal subjects ($p < 0.01$). Mean VCDR obtained from the non-mydratic fundus camera (both before and after dilation of pupil) and standard indirect ophthalmoscopy with 78 D were not significantly different ($F = 1.65$; $p = 0.2$, one way ANOVA).

The mean ophthalmoscopically estimated VCDR was (mean \pm SD) 0.479 ± 0.18 , compared with a VCDR of (mean \pm SD) 0.462 ± 0.18

measured with the non-mydratic fundus camera (difference 0.017; 95% confidence interval [CI], 0.005–0.028; $p = 0.007$). The correlations between estimated VCDR from the non-mydratic fundus camera and indirect ophthalmoscopy with 78 D lens in normal and glaucoma patients were shown in pictures 1 and 2. Moderate correlation was found in normal subjects ($r = 0.663$; $p = 0.001$) while excellent correlation was found in glaucoma patients ($r = 0.85$; $p < 0.001$). The overall correlation between the non-mydratic fundus camera and indirect ophthalmoscopy with 78 D lens is 0.895 ($p < 0.001$).



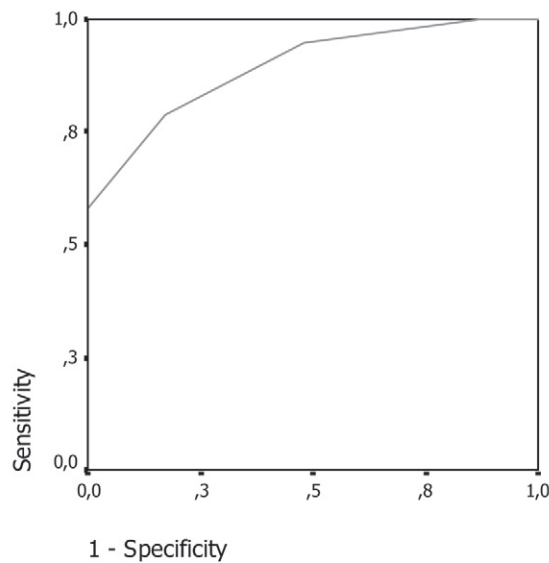
Picture 1 Graph shows correlation between estimated VCDR from non-mydratic fundus camera and indirect ophthalmoscopy with 78 D lens in normal group



Picture 2 Graph shows correlation between estimated VCDR from non-mydriatic fundus camera and indirect ophthalmoscopy with 78 D lens in glaucoma group

Picture 3 shows the area under ROC of estimated VCDR from the non-mydriatic fundus camera when used without pupillary dilation. The area under the ROC curve is equal to $0.895 \pm SE 0.05$. From the ROC at 90% specificity, the

estimated VCDR yields 68.4% sensitivity. The ROC of the estimated VCDR from the non-mydriatic fundus camera when used with pupillary dilation gave similar results. (ROC $\pm SE = 0.895 \pm 0.047$)



Picture 3 ROC of estimated VCDR from non-mydriatic fundus camera when used without pupillary dilation

Discussion

The non-mydratic fundus camera has been used for diabetic retinopathy screening for more than a decade¹. There are a limited number of studies regarding the application of the non-mydratic fundus camera for glaucoma screening^{12,13,14}. One of the drawbacks of the non-mydratic fundus camera is that, even with true color, it provides 2-dimensional, monoptic images. The depth of the optic cup, which is crucial for optic nerve head assessment in glaucoma, cannot be directly appreciated. Estimation of optic cup from disc pallor might underestimate the VCDR and compromise glaucoma detection^{6,7}. As a result, the measurement of VCDR from the non-mydratic fundus camera should rely on the course of blood vessels, traveling along the disc margin, not on the disc pallor. By this mean, the estimated VCDR should be more accurate. Thus, the differences between the ophthalmoscopically estimated VCDR and from the non-mydratic VCDR in our study was not a surprise. Even though the difference reached the statistically significant level ($p=0.007$), clinically, this small difference (0.017) is usually disregarded in VCDR evaluation.

Our study shows that measurement of VCDR from the non-mydratic fundus camera is comparable to standard indirect ophthalmoscopy with a 78 D lens, with moderate correlation in the normal group and excellent correlation in the glaucoma group. The slight difference between two groups can partly be explained by the power of differentiation which improves when glaucoma severity is more established. However, our study

did not make a distinction between mild, moderate and advanced stages of glaucoma severity; thus, we cannot conclude whether or not this test is more sensitive when the disc damage is more pronounced.

When used with pupillary dilation, the non-mydratic fundus camera did not give any significant improvement in VCDR estimation. Our result confirmed the study from Taylor, *et al*⁴. which showed similar sensitivity and specificity of the non-mydratic fundus camera and polaroid camera after pupillary dilation in diabetic screening. Thus, the outcomes confirmed the ease of use of the non-mydratic fundus camera without affecting the accuracy of the test. Further, the substantial signs for glaucoma progression such as disc hemorrhage, focal rim thinning, notching and quite often retinal nerve fiber layer defect, can be demonstrated by the non-mydratic fundus camera¹¹. The results suggested that the non-mydratic fundus camera can be a practical and useful tool, especially for mass screening for glaucoma. This can be done in conjunction with routine diabetic retinopathy screening.

From the ROC (figure 1), the sensitivity of the estimated VCDR from the non-mydratic fundus camera for differentiation between glaucoma and normal groups was not very high (68.4 at 90% specificity). One might argue that the good screening test should be able to pick up as many as possible (more sensitive) suspected cases. In this study, we considered solely the estimated VCDR. Intraocular pressure was not used for calculation, but for defining the case of glaucoma.

So this sensitivity did not reflect the true sensitivity of glaucoma detection, but rather suggested the possibility of combining this test with IOP measurement for glaucoma screening.

In conclusion, our study confirmed the good correlation between the standard measurement of VCDR and the non-mydriatic fundus camera without the need of pupillary dilation. This proved to be a fast, non-invasive, and effective way to evaluate the appearance of the optic nerve head. Combining this test with IOP measurement would make a practical and useful tool for mass glaucoma screening.

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การวิจัยเรื่องความแม่นยำในการใช้ Non Mydriatic Fundus Camera ในการประเมินขนาด ของขั้วประสาทตาสำหรับประเมินผู้ป่วยโรคต้อหิน

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บทคัดย่อ:

วัตถุประสงค์: เพื่อศึกษาถึงประสิทธิภาพในการใช้ Non mydriatic fundus camera ในการประเมินขนาดของขั้วประสาทตาว่ามีความแม่นยำมากน้อยเพียงใด เมื่อเทียบกับการประเมินขั้วประสาทตาด้วยวิธีมาตรฐานที่ดูด้วยกล้องตรวจตา slit lamp ร่วมกับ indirect lens (78 D)

ลักษณะการวิจัย: Cross-sectional descriptive comparative study

วิธีการวิจัย: ทำการศึกษาในกลุ่มคนไข้จำนวน 42 คน โดยทำการเปรียบเทียบในกลุ่มที่ได้รับการวินิจฉัยว่าเป็นต้อหินจำนวน 19 คน กับกลุ่มควบคุมที่เข้ามารับการตรวจตาด้วยโรคอื่น ๆ จำนวน 23 คน โดยทั้งสองกลุ่มจะได้รับการวัดขนาดของขั้วประสาทตาจากการประเมินรูปถ่ายขั้วประสาทตาที่ถ่ายด้วยกล้อง Non mydriatic fundus camera เทียบกับวิธีมาตรฐานโดยการดูด้วย slit lamp คู่กับ indirect lens (78 D) ขนาดความกว้างของขั้วประสาทตาในแนวตั้ง (vertical cup to disc ratio; VCDR) ที่ได้จากการตรวจทั้งสองแบบจะถูกนำมาเปรียบเทียบกัน นอกจากนั้นจะดูผลของการใช้ขยายม่านตาที่มีต่อขนาดของขั้วประสาทตาที่ประเมินได้จากการวัดด้วยวิธีทั้ง 2 อย่างร่วมด้วย

ผลการวิจัย: ค่าเฉลี่ยของ VCDR ที่วัดได้จาก indirect lens (78 D) มีค่า (mean \pm SD) 0.479 ± 0.18 , เมื่อเทียบกับ VCDR ที่วัดได้จากการประมาณขนาดของขั้วประสาทตาที่ได้จากภาพถ่ายจาก Non mydriatic fundus camera (0.462 ± 0.18) (ค่าความแตกต่างเฉลี่ย 0.017 ; 95% confidence interval [CI], $0.005-0.028$; $p=0.007$) ความสัมพันธ์ของค่าที่วัดได้จากเครื่องมือทั้งสองชนิด (correlation) อยู่ในเกณฑ์ดีมาก ($r=0.895$; $p<0.001$) และที่ความแม่นยำ (specificity) 90% ค่าความไว (sensitivity) ของเครื่อง Non mydriatic fundus camera ในการคัดกรองโรคต้อหินอยู่ในระดับปานกลางที่ประมาณ 68.4%

สรุปผลการวิจัย: การประเมินขนาดของขั้วประสาทตาด้วยเครื่อง Non mydriatic fundus camera นั้นเป็นวิธีการที่ไม่ต้องอาศัยการหยอดขยายม่านตา และให้ผลใกล้เคียงกับวิธีวัดขนาดแบบมาตรฐานด้วยการดูด้วย indirect lens (78 D) ซึ่งเมื่อใช้ร่วมกับการวัดความดันลูกตาแล้ว เครื่องมือนี้ก็จะช่วยอำนวยความสะดวกและเป็นประโยชน์อย่างมากสำหรับการประเมินขั้วประสาทตาสำหรับการคัดกรองต้อหินในผู้ป่วยที่มาตรวจตาด้วยโรคทั่วไปได้เป็นอย่างดี

