

Relationship between age and peripapillary retinal nerve fibre layer thickness: an optical coherence tomography study

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Objective To evaluate the relationship between age and peripapillary retinal nerve fibre layer thickness in healthy Chinese subjects.

Design Cross-sectional study.

Setting Regional hospital, Hong Kong.

Participants Healthy volunteers (n=218) of Chinese ethnicity with spherical equivalent of -6 to +4 dioptres were recruited for study from October 2001 to March 2003. Ocular examination was carried out and measurements of peripapillary retinal nerve fibre layer thickness were performed using optical coherence tomography (Carl Zeiss Humphrey OCT 2 machine), in a circular pattern of 3.4 mm diameter, centred on the optic disc.

Main outcome measures Mean retinal nerve fibre layer thickness and age.

Results The mean age was 40 (standard deviation, 17; range, 11-69) years. The mean peripapillary retinal nerve fibre layer thickness was 111.6 (standard deviation, 18.5; range, 52.0-155.0) μm . Age correlated significantly with peripapillary retinal nerve fibre layer thickness ($r = -0.28$, $P < 0.0001$).

Conclusion Mean peripapillary retinal nerve fibre layer thickness (based on optical coherence tomography) correlates negatively with age, which can interfere with the assessment and monitoring of glaucoma patients. An age-adjusted normogram may be necessary to interpret results.

Introduction

Optical coherence tomography (OCT) involves a device to image the retina under high resolution (10-14 μm), using low-coherence near-infrared interferometry.¹ It has been widely used in assessing macular conditions like diabetic maculopathy, macular hole, and pseudophakic cystoid macular oedema. Its use has also been extended to the monitoring and detection of glaucoma.^{2,3} The peripapillary retinal nerve fibre layer thickness (pRNFLT) is the most commonly measured parameter in glaucoma patients, for which OCT has been widely used.^{4,5} Moreover, pRNFLT has been shown to correlate with visual field defects, and therefore monitoring it can be very valuable in assessing glaucoma progress.⁶

Whether retinal nerve fibre layer thickness varies with age has also been studied using both histological and optical means.⁷⁻¹¹ Detailed correlations of pRNFLT in the peripapillary region with age have only been described in the western populations,¹² but to date not in a Chinese population. This may have practical implications for the detection and monitoring of glaucoma. Therefore, the main aim of this study was to investigate the variations in pRNFLT with age in healthy Chinese volunteers.

Methods

The study was conducted according to recommendations in the Declaration of Helsinki. Healthy volunteers were recruited through health talks in schools and hospitals, carried out as part of the Eye Screening Project, supported by the Tung Wah Group Research Fund (from October 2001 to March 2003).

In all, 218 ophthalmologically normal volunteers with spherical equivalent of -6 to +4 dioptres agreed to enter the programme. After examination by an ophthalmologist (including visual acuity, applanation tonometry, refraction and frequency-doubled

Key words

Image processing, computer-assisted;
Nerve fibers; Optic nerve; Retina;
Tomography

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利用光學相干斷層成像術研究年齡與視盤周圍視網膜神經纖維層厚度的關係

目的 檢測健康的華籍人士的年齡與視盤周圍視網膜神經纖維層厚度之間的關係。

設計 橫斷面研究。

安排 香港一所分區醫院。

參與者 2001年10月至2003年3月期間共218位眼屈光度為-6至+4的健康華籍人士參與。利用光學相干斷層成像術 (Carl Zeiss Humphrey OCT 2) 進行內眼檢查，並對視盤為中心直徑3.4 mm的視網膜神經纖維層的厚度進行量度。

主要結果測量 視網膜神經纖維層的平均厚度及年齡。

結果 參與者平均年齡40歲 (標準差: 17歲, 介乎11至69歲), 視盤周圍視網膜神經纖維層的厚度平均111.6 μm (標準差: 18.5 μm , 介乎52.0至155.0 μm)。年齡與視盤周圍視網膜神經纖維層的厚度明顯相關 ($r = -0.28$, $P < 0.0001$)。

結論 根據光學相干斷層成像術的檢測, 年齡越大, 視盤周圍視網膜神經纖維層越薄, 這會干擾對白內障病人的檢測和監控。因此, 以年齡調整的列線圖來評鑑量度結果是需要的。

perimetry [FDP] testing), their pupils were dilated and OCT scans were obtained with an internal fixation target. All subjects underwent FDP testing, and anyone with an abnormal deviation was recruited only if the results of Humphrey Visual Field testing were within normal limits. Subjects with abnormal results on both FDP and Humphrey fields were excluded.

The Carl Zeiss Humphrey OCT2 (Humphrey instruments, Hacienda Drive, Dublin [CA], US; software version A6.1) was used. Circular scans were performed concentrically around the optic disc, up to a diameter of 3.40 mm; 100 A-scans were performed per circular scan giving a total of 300 A-scan results per eye. The scanning diameter of up to 3.40 mm was chosen because this was widely used in glaucoma studies and yielded better results than others.^{2,3,6,11}

The average pRNFLT in the superior and inferior quadrants were divided by the temporal quadrants thickness to give the superior/temporal ratio (STR) and the inferior/temporal ratio (ITR), respectively. These two values are readily available on OCT reports if needed, and provide alternatives to absolute pRNFLT values. Being independent of other variables (ie cup-disc ratio, disc size, etc), these values may be superior to absolute retinal nerve fibre layer thickness for gauging glaucoma. We also correlated these values with age.¹³

TABLE. Distribution of age and respective mean peripapillary retinal nerve fibre layer thickness (pRNFLT) values

Age-group (years)	No. of subjects	pRNFLT (mean \pm standard deviation) [μm]
10-19	37	122.8 \pm 16.3
20-29	38	114.6 \pm 18.1
30-39	36	108.6 \pm 13.9
40-49	34	115.6 \pm 25.9
50-59	35	107.2 \pm 18.0
60-69	38	106.2 \pm 21.8
Total	218	111.6 \pm 18.5

Only the data from the left eye of each subject were selected for analysis. Statistical analysis was carried out using the Statistical Package for the Social Sciences (Windows version 10.0; SPSS Inc, Chicago [IL], US), and a P value of less than 0.05 was considered statistically significant.

Results

All 218 subjects were ethnic Chinese, of which 108 were male. The mean age was 40 (standard deviation [SD], 17; range, 11-69) years. The mean pRNFLT was 111.6 (SD, 18.5; range, 52.0-155.0) μm . The mean STR was 2.06 (SD, 0.67; range, 0.52-4.27). The mean ITR was 2.12 (SD, 0.53; range, 0.68-4.40). Details of the distribution of age and mean pRNFLT are shown in the Table.

Age correlated significantly with pRNFLT ($r = -0.28$, $P < 0.0001$) [Fig 1]. The STR was independent of age ($r = 0.003$, $P = 0.97$), as was ITR ($r = 0.08$, $P = 0.26$), and their respective scatterplots are shown in Figures 2 and 3.

Discussion

In general, retinal nerve fibre layer thickness decreases with age.⁷⁻¹¹ However, hitherto the relationship between age and pRNFLT has not been well documented. To date, there has been only one report measuring only the temporal rim using the OCT.¹¹ In our study, we calculated the average pRNFLT in healthy subjects and studied its relationship with age.

Our population was spread across different age-groups, and therefore likely to be representative of a range of age-groups. We found that pRNFLT decreased significantly with advancing age ($P < 0.0001$). In the monitoring of glaucoma patients, this phenomenon may interfere with the interpretation of OCT scans, and hence attention must be paid to patient age. We did not include subjects aged 69 years or more, as beyond this age they are liable to develop cataracts and/or may already have undergone

cataract surgery—both of which interfere with OCT scanning. Although the optical nature of OCT scans in older individuals prevents accurate measurements when the lens media are not optically clear, there is little doubt that older subjects endure larger effects on pRNFLT than those who are younger.

Although there is a significant decrease in the thickness of the peripapillary fibre layer, visual function measured in terms of the Humphrey visual field was normal in all our subjects. This suggests that there may be some degree of reserve in the nerve fibre layer, and visual field defects may not be elicited until a substantial part of the nerve fibre layer is lost. This too is consistent with the belief that glaucoma starts with anatomical changes well before functional loss is evident.^{6,14}

The STR and ITR are both independent of age, and thus may possibly be more accurate than the absolute values, for gauging glaucoma. More studies, however, are needed before a normogram is available for comparison.

Notably, mean pRNFLT increased from 108.6 μm in the 30-39 years' age-group to 115.6 μm in the 40-49 years' group. This increase did not correlate with the general decreasing trend. When divided into males and females, the mean pRNFLT was 109.5 (SD, 20.0) μm and 117.9 (SD, 20.3) μm , respectively. The trend in males seemed to correspond better with the general picture while that in females appeared to deviate to a larger degree. We do not have an explanation for this phenomenon, but in women the menopause may have a role and requires further investigation.

The strength of our investigation was that all the subjects were ethnic Chinese, for which our data could provide future reference values, but applicability to other races is also possible. One limitation of this study was the slow scan speed of our OCT2 machine, as compared with newer generation OCT3 or spectral domain OCT machines. The latter were not available to us till after our study was completed. Another study, however, has shown that there is a high degree of correlation between OCT2 and OCT3 readings,¹⁵ and so we have confidence in our OCT2 readings.

In conclusion, we found that pRNFLT correlated negatively with age using OCT scans, and that this could interfere with assessment and monitoring of glaucoma patients. In addition, STR and ITR were independent of age, which may offer alternatives to the pRNFLT alone as a means of monitoring glaucoma.

Declaration

No conflicts of interest were declared by the authors.

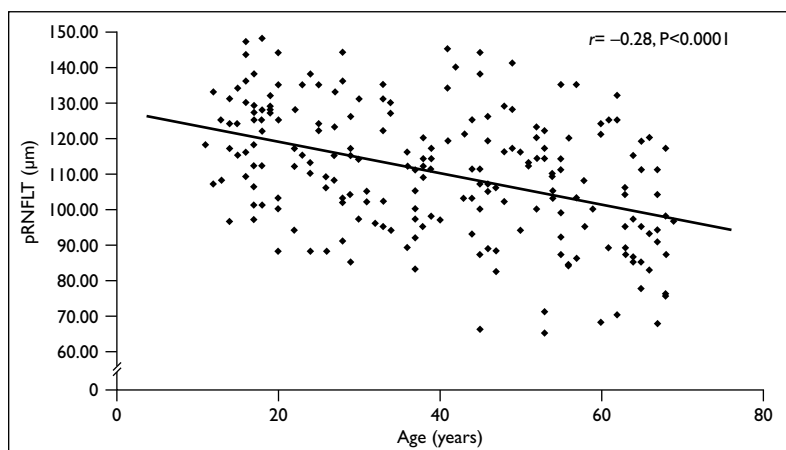


FIG 1. Scatterplot of age versus peripapillary retinal nerve fibre layer thickness (pRNFLT)

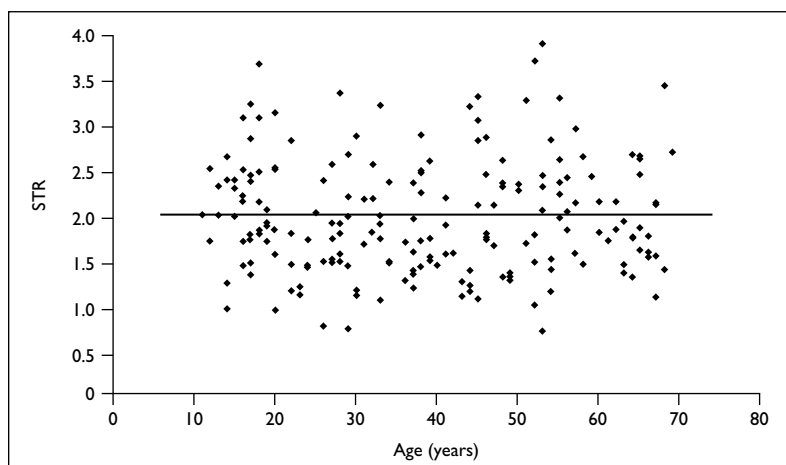


FIG 2. Scatterplot of age versus superior/temporal ratio (STR)

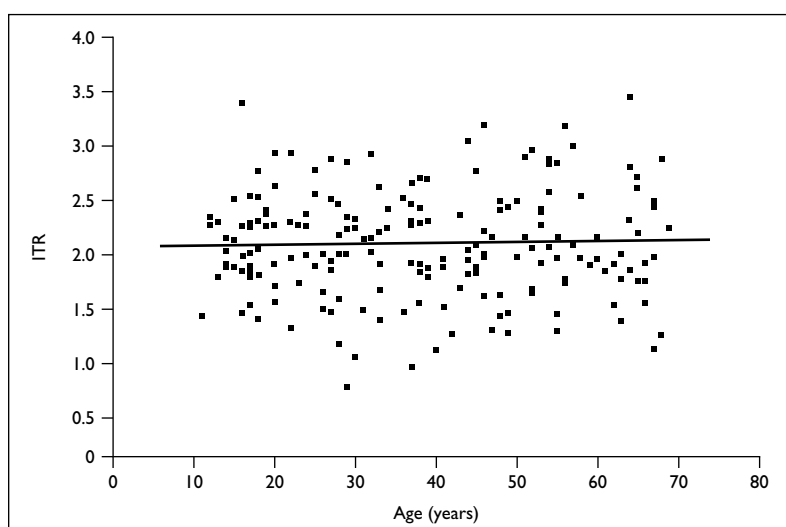


FIG 3. Scatterplot of age versus inferior/temporal ratio (ITR)

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Corrigenda

“Association of sleep hygiene–related factors and sleep quality among university students in Hong Kong” (June 2010;16:180-5). On page 182, Table 1, the dagger after item 5 (“Eat heavy night snack before bedtime”) should have been removed. In Table 2, an asterisk (* Containing caffeine) should have been added after the following items: 1 (Chinese tea), 2 (Western tea), 4 (Cola soft drink), 5 (Chocolate milk), 8 (Lucozade), 9 (Regular coffee), 10 (Energy drink), 12 (Honey green tea), 13 (Lemon tea), and 16 (Tonic vitaminised drink).