Retinal Nerve Fiber Layer Thickness After a Single Attack of Primary Acute Angle-Closure Glaucoma Measured With Optical Coherence Tomography

Ian Y. H. Wong, MRCSEd(Oph); Nancy S. Y. Yuen, FHKAM(Oph); Clement W. N. Chan, FHKAM(Oph)

BACKGROUND AND OBJECTIVE: After a single unilateral acute primary angle-closure glaucoma attack, retinal nerve fiber layer (RNFL) may be thinned. The current study measured the RNFL thickness using optical coherence tomography in eyes with normal visual fields after recovery from a single attack of acute primary angle-closure glaucoma.

PATIENTS AND METHODS: Twenty-one patients and age-matched control subjects underwent optical coherence tomography scanning after recovery from a single unilateral acute primary angle-closure glaucoma attack. Data from the affected eyes, normal fellow eyes, and control subjects were compared.

RESULTS: Average RNFL thickness was 91.3 ± 16.4 µm in the affected eyes, 100.1 ± 16.4 µm in the fellow eyes, and 100.2 ± 16.7 µm in the control eyes. Significant thinning was present in the affected eyes compared to the fellow eyes (P = .001) and the control eyes (P = .04).

CONCLUSION: RNFL thickness was found to be significantly thinner in the eyes with angle-closure glaucoma.

INTRODUCTION

During an acute primary angle-closure glaucoma attack, intraocular pressure (IOP) may be elevated to a high level. Even if the attack is aborted and IOP normalized as quickly as possible, retinal nerve fiber layer (RNFL) thickness may still be thinned. Previous studies using scanning laser polarimetry have shown that RNFL can be thinned after a single acute primary angle-closure glaucoma attack. Disc pallor may also be observed. In early glaucoma, RNFL thinning may precede visual field loss. In a study by Aung et al., 62% of patients did not have any visual field defects after a...
single acute primary angle-closure glaucoma attack at 6 months. We do not know whether these cases eventually go on to develop visual field defect.

The purpose of the current study was to measure the RNFL thickness using optical coherence tomography (OCT) in eyes with normal visual fields after recovery from a single attack of acute primary angle-closure glaucoma.

**PATIENTS AND METHODS**

This cross-sectional study was conducted in accordance with the Declaration of Helsinki. Consent from each patient and control subject was obtained. Inclusion criteria were: (1) a history of a single unilateral acute primary angle-closure glaucoma attack, which was a clinical diagnosis made from typical signs and symptoms (ie, headache, vomiting, seeing halo, mid-dilated pupil, corneal edema, shallow anterior chamber, closed angle, and elevated IOP on presentation); (2) the fellow eye did not suffer any acute primary angle-closure glaucoma attack but had occludable angles at presentation; (3) the IOP remained less than 21 mm Hg after treatment with medication and laser iridotomy and remained less than 21 mm Hg without any antiglaucoma drops at 3 months after the attack; (4) duration of attack was less than 48 hours; and (5) the patient had normal visual fields at 3 months after the attack. Exclusion criteria were: (1) a history of previous acute primary angle-closure glaucoma attack or bilateral acute primary angle-closure glaucoma attack; (2) the patient developed chronic glaucoma (ie, use of antiglaucoma drops to maintain an IOP of less than 21 mm Hg at 3 months after the attack; (3) preexisting ocular pathologies or history of ocular surgery; or (4) best-corrected visual acuity worse than 20/50 and spherical equivalent outside the range of +4 to -4 diopters.

Twenty-one patients were included in the study. Age-matched control subjects were recruited from normal subjects from outpatient clinics who had (1) IOP lower than 21 mm Hg, (2) open angles, (3) no visual field defects, and (4) discs that were normal and pink with a cup-to-disc ratio no higher than 0.5. Data from only one eye (left) of each control subject were selected for comparison to avoid selection bias.

**Scanning**

All subjects were treated medically at presentation and laser iridotomy was performed as soon as the cornea cleared. Prophylactic iridotomy was performed in the fellow eye at either the initial session or at the earliest available session. After remission, pupils were dilated and were at least 5 mm before OCT scans were performed.

RNFL thickness was measured using the Stratus OCT 3000 (version 4.0.2; Carl Zeiss Meditec, Dublin, CA). The fast RNFL thickness protocol was used. All scans were performed by a single experienced operator to eliminate interobserver variability. Scans with signal strength lower than 8 were discarded.

**Visual Field Testing**

All subjects, including control subjects, underwent testing using Humphrey automated perimetry Swedish interactive thresholding algorithm standard 24-2 (Carl Zeiss Meditec). All visual fields were performed at least 3 months after the attack. Reliability criteria were false-negative less than 33%, false-positive less than 33%, and fixation loss less than 20%. Normal visual field was defined as mean deviation and pattern standard deviation within 95% confidence intervals and a glaucoma hemifield test result “within normal limits.”

**Analysis**

The following RNFL thickness parameters were analyzed: average, superior quadrant, nasal quadrant, temporal quadrant, and inferior quadrant. The paired Student’s $t$ test was used for comparison between the affected eyes and fellow eyes and the unpaired Student’s $t$ test was used to compare results for the affected eyes and fellow eyes with those of control subjects separately. To confirm our assumption that RNFL thickness was similar between both eyes of the control subjects, a paired Student’s $t$ test was also done. A $P$ value of less than .05 was considered significant.

**RESULTS**

Patient demographics and detailed RNFL measurements are listed in Table 1. Distribution of RNFL thickness is shown in the figure. Significant differences were found between the average, superior quadrant, and inferior quadrant RNFL thicknesses between the affected eyes and the fellow eyes. The same findings (ie, average, superior quadrant, and inferior quadrant RNFL thickness) were also noted when comparing the affected eyes and control eyes.
However, no significant differences were found between any measurements when comparing the fellow eyes with control eyes. Average RNFL thickness differences between the right and left eyes among control subjects were also statistically insignificant ($P = .314$), which confirms our assumption that RNFL was similarly thick between both eyes of each control subject. Detailed results of the statistical analysis are listed in Table 2.

### DISCUSSION

In the current study, the RNFL was found to be significantly thinner in eyes that had undergone an acute primary angle-closure glaucoma attack. Our results confirmed those of a recent study using OCT in which the average and inferior quadrant RNFL were found to be thinned; in addition, we found that the superior quadrant was also thinned significantly. This is in agreement with the concept that the inferior and superior fibers are the first to be affected in glaucoma.

Although there were significant reductions in RNFL thickness, no functional changes (ie, visual field defects) were observed. We do not know whether these “functionally normal” cases eventually develop glaucoma features. They either remain functionally normal or may develop visual field defects some later point.\(^7\)\(^-\)\(^10\)

In a study by Bonomi et al., only 15% of the cases demonstrated normal visual field 1 month after acute primary angle-closure glaucoma attack.\(^7\) In a study by Aung et al., 38% demonstrated significant visual field defects 6 months after the attack.\(^4\) However, there are no studies to date that can quantify the rate of RNFL thinning and predict the onset of field defect or glaucoma.\(^11\)\(^,\)\(^12\)

In Aung's study, both the superior and inferior RNFL thickness was found to decrease from 2 to 16 weeks after the acute primary angle-closure glaucoma attack.\(^1\) This hints that perhaps RNFL reduction is an ongoing process rather than a one-off insult during the attack. Therefore, after an episode of acute primary
angle-closure glaucoma, even without features of glaucoma, patients should still be closely followed up and monitored both clinically and with OCT and visual field testing in case they eventually develop chronic glaucoma.

Another possibility for RNFL thinning in affected eyes is that these predisposed eyes may have subclinical elevation of IOP even before the symptomatic acute primary angle-closure glaucoma attack. Therefore, RNFL thinning in these patients may have contributing factors other than the genuine clinical acute primary angle-closure glaucoma attack alone.

The main limitation of our study was that we were unable to compare our data with the data from before the acute primary angle-closure glaucoma attack. This was largely due to the fact that none of the patients were seen before the acute primary angle-closure glaucoma attack. Even if they had been, prophylactic iridotomy would have been performed and they would not have had an acute primary angle-closure glaucoma attack alone. The only way of postulating the pre-attack RNFL thickness was to use the data from the fellow eye, assuming that RNFL thickness was similar bilaterally. Another limitation was our small sample size. This may be due to the stringent inclusion criteria we used. There is a need for a larger-scale patient recruitment program and longer follow-up in the future.

Average, superior quadrant, and inferior quadrant RNFL thickness was found to be significantly thinner in eyes after an acute primary angle-closure glaucoma attack.

**REFERENCES**