

# Optic disc topography in Malay patients with normal-tension glaucoma and primary open-angle glaucoma

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**Background:** There are limited data concerning the optic disc topography in normal-tension glaucoma (NTG) and primary open-angle glaucoma (POAG) patients living in Southeast Asian countries. This study aims to compare optic disc parameters in patients with NTG and POAG in Malaysia and to discuss the results in comparison with studies of NTG and POAG in other Asian countries.

**Methods:** This prospective cross-sectional study was performed in two hospitals with glaucoma service in Malaysia from 2010 to 2012. Seventy-seven patients of Malay ethnicity were enrolled in this study, including 32 NTG patients and 45 POAG patients. Using the Heidelberg Retinal Tomograph III, we measured optic disc area, cup area, rim area, cup volume, rim volume, cup-to-disc area ratio, mean cup depth, maximum cup depth, cup shape measure, height variation contour, mean retinal nerve fiber layer thickness, and retinal nerve fiber layer cross-sectional area.

**Results:** The eyes for NTG patients had significantly larger optic disc areas (2.65 [standard deviation, 0.41] vs 2.40 [standard deviation, 0.36] mm<sup>2</sup>, respectively;  $P=0.006$ ) and cup areas (1.54 [standard deviation, 0.43] vs 1.32 [standard deviation, 0.40] mm<sup>2</sup>, respectively;  $P=0.027$ ) compared with the eyes of POAG patients. Comparison of the other parameters between the two groups revealed no significant difference ( $P>0.050$ ). The moderate and severe NTG patients showed significantly deeper cups and larger disc and cup areas when compared with the moderate and severe POAG patients ( $P<0.050$ ).

**Conclusion:** The NTG patients in this study have notably larger optic disc and cup areas than the POAG patients. Our observations are consistent with those reported in studies of NTG and POAG patients in Korea. The deeper cups and larger disc and cup areas may serve as indicators of severity when comparing NTG with POAG. However, these findings require verification with IOP and visual field results.

**Keywords:** normal-tension glaucoma, primary open-angle glaucoma, Malay ethnicity, optic disc topography, Heidelberg Retina Topography III

## Introduction

Normal-tension glaucoma (NTG) is more common than primary open-angle glaucoma (POAG) in Northeast Asian countries. The prevalence rate of NTG in Japan and Korea ranges from 2.0% to 3.6%, whereas the rate of POAG ranges from 0.2% to 0.8%.<sup>1-5</sup> However, the scenario is different in the Southeastern Asian region. The prevalence of NTG was reported to be lower than that of POAG in Malaysia, Thailand, and the Philippines.<sup>6-9</sup>

The Malay ethnicity represents the third largest ethnic group in Asia and remains the main ethnic group in Malaysia, Indonesia, and Brunei. Previous descriptions of

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the appearance of the optic disc in glaucomatous patients have been restricted to studies of Malay people living in Singapore.<sup>10–13</sup> There are limited data available on glaucoma patients of Malay ethnicity outside of Singapore.

The Heidelberg Retinal Tomograph (HRT) III (Heidelberg Engineering, Heidelberg, Germany) has been widely used to describe the characteristics of the optic disc in glaucoma patients in recent years.<sup>14–20</sup> Our study aims to investigate the differences in optic disc parameters between NTG and POAG patients of Malay ethnicity in Malaysia, using HRT III analysis.

## Methods

This was a prospective comparative cross-sectional study involving patients with NTG and POAG at two Glaucoma Service Units in Malaysia from November 2010 to February 2012. We recruited 77 Malay patients, including 32 NTG and 45 POAG patients. Approval was obtained from the Ethical Committee of the Ministry of Health, Malaysia, and the Research and Ethical Committee at the School of Medical Sciences, Universiti Sains Malaysia. The study protocol was conducted in accordance with the Declaration of Helsinki on human research. Written informed consent was obtained from all patients in the study.

The study details were described previously.<sup>21</sup> NTG patients were recruited on the basis of clinical criteria defined by the Collaborative Normal Tension Glaucoma Study,<sup>22</sup> which included the presence of glaucomatous cupping with a corresponding visual field defect and a median intraocular pressure (IOP) of less than 21 mmHg, but never exceeding 24 mmHg, in at least 10 readings conducted in either eye.

Patients with POAG were defined as having glaucomatous optic neuropathy in the presence of an open angle and no other ocular abnormality to account for a secondary mechanism.<sup>23</sup> POAG patients with an IOP of more than 21 mmHg were considered in this study. The subjects recruited in both studied groups were of Malay ethnicity extending back at least two generations, including all parents and grandparents.

For both groups, we excluded patients' congenital and secondary glaucoma, gonioscopic findings of a closed angle, the presence of peripheral anterior synechiae, pseudoexfoliation membrane, angle recession and new vessel formations at the angle, dense media opacity, myopia greater than  $-6.0$  diopter, and a tilted optic disc. Patients with diabetic retinopathy, retinitis pigmentosa, nonglaucomatous optic neuropathy, or central nervous system diseases were also excluded.

All patients underwent a thorough ocular assessment, including evaluation of the visual acuity, refraction, IOP measurements, and anterior segment, as well as funduscopy, gonioscopy, and fundus photograph documentation. IOP phasing was performed in the NTG group. The vertical cup disc ratio was determined on the basis of clinical examination and the evaluation of fundus photographs by an identified glaucoma specialist at both centers. Both groups of patients were further subcategorized as having clinical moderate glaucoma when the vertical cup disc ratio ranged from 0.7 to 0.8, or clinically advanced glaucoma when the vertical cup disc ratio ranged from 0.9 to fully cupped.

All patients underwent visual field assessment with 24-2 program. An age- and power-adjusted spherical correction was added to the distance refraction to achieve best corrected vision. The loss of visual field was considered significant when three or more congruous nonedge points were present in the typical arcuate area, a depressed pattern deviation plot at a  $P < 5\%$  level with at least one point depressed at a  $P < 1\%$  level was observed, the corrected pattern standard deviation was significant at the  $P < 5\%$  level, and the Glaucoma Hemifield Test was outside the normal limits.

A minimum of two reliable visual field tests was required. The visual field assessments were considered reliable only when the false-positive rate was 15% or lower, the false-negative rate was 30% or lower, and the fixation loss was less than 15%.

The Advanced Glaucoma Intervention Study (AGIS) score was calculated on the basis of the results of the visual field assessment with the 24-2 program (Swedish Interactive Threshold Algorithm standard). All patients were then subcategorized as having mild (1–5 points), moderate (6–11 points), or end-stage impairment of the visual field (12–20 points), according to the score.<sup>24</sup>

All patients underwent the HRT III. The analysis of optic disc topography was performed by an identified investigator at each center. High-quality images were ensured according to the criteria described by Bowd et al.<sup>25</sup> The data were obtained from the right eye if both eyes were eligible, or from the worse eye in asymmetrical cases.

The data analyses were performed using Predictive Analysis Software statistics version 18.0 (IBM Corporation, Armonk, NY, USA). Demographic and ophthalmic data were compared using an independent *t*-test for continuous variables that were normally distributed. Comparisons between the groups were performed with the Mann–Whitney rank sum test for continuous variables that were not normally distributed. A *P*-value of  $< 0.05$  was considered statistically significant.

## Results

A total of 77 patients were included in the study (NTG  $n=32$ , POAG  $n=45$ ). The mean ages of the NTG and POAG groups were 64.0 years (standard deviation, 9.3 years) and 64.9 years (standard deviation, 9.2 years), respectively. There was a slightly higher number of women in the POAG group (55.6%) compared with in the NTG group (50.0%). The severity of glaucoma in both groups was further objectively subcategorized on the basis of the clinical assessment and the AGIS score. These data are summarized in Table 1.

Table 2 presents the comparison of the mean optic disc parameters between the NTG and POAG groups. Patients with NTG had significantly larger disc and cup areas than those with POAG ( $P=0.006$  and  $P=0.027$ , respectively). The other HRT III parameters such as rim area, cup volume, rim volume, vertical cup/disc ratio, mean cup depth, and mean retinal nerve fiber layer thickness were not significantly different between patients with NTG and those with POAG ( $P>0.05$ ).

Tables 3 and 4 describe the comparison of the NTG and POAG on the basis of the clinical assessment. The moderately

severe NTG patients were noted to present significantly deeper cups compared with their POAG counterparts ( $P=0.02$ ). Meanwhile, advanced NTG patients had significantly larger cup areas when compared with advanced POAG patients ( $P=0.039$ ). The other optic nerve head parameters were comparable between the two groups ( $P>0.05$ ).

The disc area was significantly larger in moderately severe and advanced NTG patients when compared with the POAG patients, based on the AGIS score ( $P=0.032$  and  $P=0.026$ , respectively). These findings are summarized in Tables 5 and 6. We did not detect any significant difference in this parameter between the group with mild NTG and the group with mild POAG ( $P>0.05$ ). No significant differences were detected in the other optic nerve head parameters between the two groups, based on severity according to AGIS score ( $P>0.05$ ).

## Discussion

Table 7 describes the published articles reporting comparisons of optic disc topography between NTG and POAG patients from Asia; the majority of these studies were carried out in Korea and Japan.<sup>26–29</sup> We were unable to find any other comparison studies on similar topics in other Asian populations. Confocal scanning laser tomography and HRT analysis were used in the previously published studies.<sup>26–29</sup> HRT III was implemented in our study. Because of the different modalities used in these studies, we intend to compare the observed trends, but we are unable to directly compare the measurement of all parameters between studies.

We observed that the mean disc area in NTG patients was significantly larger compared with in the POAG group. Our observation is consistent with the results of Korean studies.<sup>26,27</sup> Yang and Park noted that the mean disc area was  $2.70\pm 0.51$  mm<sup>2</sup> in NTG patients and  $2.22\pm 0.59$  mm<sup>2</sup> in POAG patients ( $P=0.002$ ).<sup>26</sup> Shin et al reported that the mean disc area was  $2.78\pm 0.48$  mm<sup>2</sup> in NTG patients and  $2.41\pm 0.58$  mm<sup>2</sup> in POAG patients ( $P=0.001$ ).<sup>27</sup> In contrast, no significant differences in the mean disc area were detected in NTG and POAG patients from Japan and Italy.<sup>28–30</sup>

Our NTG patients had a significantly larger cup area compared with the POAG patients. This result is in agreement with reports by Shin et al and Kiriya et al.<sup>27,28</sup> Shin et al reported that the mean cup area was  $1.51\pm 0.46$  mm<sup>2</sup> in their NTG patients and  $1.11\pm 0.60$  mm<sup>2</sup> in POAG patients ( $P=0.001$ ).<sup>27</sup> Kiriya et al reported a mean cup area of  $1.46\pm 0.58$  mm<sup>2</sup> in the Japanese patients with NTG and  $1.10\pm 0.55$  mm<sup>2</sup> with POAG ( $P=0.031$ ).<sup>28</sup> However, Nakatsue et al and Lester and Mikelberg reported that

**Table 1** Demographic and clinical characteristics

Characteristic	NTG (n=32)	POAG (n=45)	P-value
Age, years			0.905*
Mean $\pm$ SD	64.0 $\pm$ 9.3	64.9 $\pm$ 9.2	
Minimum	45.0	45.0	
Maximum	84.0	82.0	
Sex, n (%)			0.630†
Female	16 (50.00%)	25 (55.60%)	
Male	16 (50.00%)	20 (44.40%)	
Selected eye, n (%)			0.685†
RE	17 (53.10%)	26 (57.80%)	
LE	15 (46.90%)	19 (42.20%)	
Spherical equivalent, D			0.431*
Mean $\pm$ SD	+0.28 $\pm$ 1.63	-0.11 $\pm$ 1.33	
MD, dB			0.773*
Mean $\pm$ SD	-10.35 $\pm$ 8.76	-11.27 $\pm$ 8.46	
CPSD, dB			0.195*
Mean $\pm$ SD	5.03 $\pm$ 3.42	6.86 $\pm$ 3.87	
VCDR, n (%)			0.307†
Clinical moderate	18 (56.25%)	20 (44.44%)	
Clinical advanced	14 (43.75%)	25 (55.56%)	
AGIS score, n (%)			0.222†
Mild	10 (31.26%)	7 (15.55%)	
Moderate	11 (34.37%)	16 (35.55%)	
Severe–end stage	11 (34.37%)	22 (48.90%)	

**Notes:** \*Independent *t*-test applied. †Pearson chi-square test applied. Level of significance was set at 0.05.

**Abbreviations:** NTG, normal-tension glaucoma; POAG, primary open-angle glaucoma; SD, standard deviation; RE, right eye; LE, left eye; D, diopter; MD, mean deviation; CPSD, corrected pattern standard deviation; VCDR, vertical cup-to-disc ratio; AGIS, Advanced Glaucoma Intervention Study.

**Table 2** Comparison of the mean values of the optic disc parameters between NTG and POAG patients

Optic disc parameters	Mean $\pm$ SD		MD (95% CI)	T stat (df)	P-value*
	NTG (n=32)	POAG (n=45)			
Disc area, mm <sup>2</sup>	2.65 $\pm$ 0.41	2.40 $\pm$ 0.36	0.26 (0.08–0.44)	2.84 (75)	<b>0.006</b>
Cup area, mm <sup>2</sup>	1.54 $\pm$ 0.43	1.32 $\pm$ 0.40	0.22 (0.02–0.40)	2.25 (75)	<b>0.027</b>
Rim area, mm <sup>2</sup>	1.12 $\pm$ 0.41	1.07 $\pm$ 0.44	0.05 (–0.15–0.24)	0.45 (75)	0.651
Cup volume, mm <sup>3</sup>	0.47 $\pm$ 0.28 <sup>†</sup>	0.40 $\pm$ 0.37 <sup>†</sup>	–	–1.32 <sup>‡</sup>	0.187 <sup>¶</sup>
Rim volume, mm <sup>3</sup>	0.23 $\pm$ 0.13	0.21 $\pm$ 0.15	0.02 (–0.05–0.08)	0.50 (75)	0.617
Cup/disc area ratio	0.58 $\pm$ 0.14	0.55 $\pm$ 0.15	0.03 (–0.04–0.09)	0.72 (75)	0.473
Linear cup/disc ratio	0.76 $\pm$ 0.09	0.74 $\pm$ 0.11	0.02 (–0.03–0.07)	0.80 (75)	0.425
Mean cup depth, mm	0.37 $\pm$ 0.09	0.35 $\pm$ 0.13	0.12 (–0.03–0.07)	0.74 (75)	0.461
Maximum cup depth, mm	0.77 $\pm$ 0.16	0.75 $\pm$ 0.23	0.02 (–0.07–0.12)	0.44 (75)	0.663
Cup shape measure	–0.04 $\pm$ 0.06	–0.06 $\pm$ 0.06	0.02 (–0.01–0.05)	–1.25 (75)	0.123
Height variation contour, mm	0.39 $\pm$ 0.19 <sup>†</sup>	0.33 $\pm$ 0.15 <sup>†</sup>	–	–1.63 <sup>‡</sup>	0.103 <sup>¶</sup>
Mean RNFL thickness, mm	0.15 $\pm$ 0.10	0.15 $\pm$ 0.08	0.00 (–0.04–0.04)	0.83 (75)	0.934
RNFL cross-sectional area, mm <sup>2</sup>	0.88 $\pm$ 0.60	0.83 $\pm$ 0.48	0.05 (–0.19–0.30)	0.43 (75)	0.670

**Notes:** \*Independent t-test was applied. <sup>†</sup>Median (interquartile range). <sup>‡</sup>Z stat. <sup>¶</sup>Mann–Whitney test was applied. Bold text indicates that the values reached significant level. **Abbreviations:** NTG, normal-tension glaucoma; POAG, primary open-angle glaucoma; SD, standard deviation; MD, mean difference; CI, confidence interval; df, degree of freedom; RNFL, retina nerve fiber layer.

there were no significant differences between these two groups.<sup>29,30</sup> Yang and Park did not mention in their analysis.<sup>26</sup> A larger optic disc size in NTG patients compared with in patients with other types of glaucoma has also been reported in non-Asian population.<sup>31,32</sup>

We noted that the cup was significantly deeper in the NTG patients compared with the POAG patients, with moderate severity on clinical assessment. However, the disc and cup areas were persistently larger in the groups with advanced disease according to the clinical assessment and AGIS scoring. Thus, we suggest that the cup depth and the disc and cup areas may serve as indicators to differentiate the severity of NTG and POAG. However, this evaluation should also be

accompanied by measurements of the IOP and visual field in clinical practice.

The cup-to-disc ratio and other optic nerve head parameters were comparable between the NTG and POAG patients in this study. This observation is in agreement with Shin et al.<sup>27</sup> Interestingly, Kiriya et al noted that their NTG patients displayed a significantly smaller mean rim area, thinner mean retinal nerve fiber layer, smaller retinal nerve fiber layer cross-sectional area, larger mean cup volume, and increased mean cup/disc area ratio when compared with POAG patients.<sup>28</sup> All optic nerve head parameters were similar between the NTG and POAG groups in the two subsequent studies.<sup>29,30</sup>

**Table 3** Comparisons of the optic disc parameters between moderate NTG and POAG patients (based on clinical assessment)

Optic disc parameters	Mean $\pm$ SD		MD (95% CI)	T stat (df)	P-value*
	Moderate NTG (n=18)	Moderate POAG (n=20)			
Disc area, mm <sup>2</sup>	2.71 $\pm$ 0.40	2.49 $\pm$ 0.38	0.22 (–0.40–0.48)	1.72 (36)	0.095
Cup area, mm <sup>2</sup>	1.38 $\pm$ 0.33	1.17 $\pm$ 0.37	0.21 (–0.02–0.44)	1.82 (36)	0.076
Rim area, mm <sup>2</sup>	1.33 $\pm$ 0.31	1.32 $\pm$ 0.44	0.01 (–0.25–0.26)	0.07 (36)	0.945
Cup volume, mm <sup>3</sup>	0.43 $\pm$ 0.18	0.31 $\pm$ 0.20	0.12 (0.00–0.25)	1.98 (36)	0.055
Rim volume, mm <sup>3</sup>	0.30 $\pm$ 0.11	0.28 $\pm$ 0.18	0.02 (–0.08–0.12)	0.40 (36)	0.694
Cup/disc area ratio	0.51 $\pm$ 0.10	0.47 $\pm$ 0.14	0.04 (–0.04–0.12)	0.94 (36)	0.354
Linear cup/disc ratio	0.71 $\pm$ 0.07	0.68 $\pm$ 0.11	0.03 (–0.03–0.09)	1.08 (36)	0.288
Mean cup depth, mm	0.37 $\pm$ 0.07	0.30 $\pm$ 0.10	0.07 (0.01–0.13)	2.44 (36)	<b>0.020</b>
Maximum cup depth, mm	0.78 $\pm$ 0.24 <sup>†</sup>	0.61 $\pm$ 0.25 <sup>†</sup>	–	2.28 <sup>‡</sup>	<b>0.023<sup>¶</sup></b>
Cup shape measure	–0.05 $\pm$ 0.05	–0.08 $\pm$ 0.05	0.03 (–0.01–0.06)	1.61 (36)	0.117
Height variation contour, mm	0.38 $\pm$ 0.09	0.36 $\pm$ 0.09	0.02 (–0.04–0.08)	0.67 (36)	0.492
Mean RNFL thickness, mm	0.21 $\pm$ 0.06	0.19 $\pm$ 0.07	0.03 (–0.02–0.07)	1.29 (36)	0.207
RNFL cross-sectional area, mm <sup>2</sup>	1.24 $\pm$ 0.35	1.04 $\pm$ 0.43	0.20 (–0.06–0.46)	1.53 (36)	0.135

**Notes:** \*Independent t-test was applied. <sup>†</sup>Median (interquartile range). <sup>‡</sup>Z stat. <sup>¶</sup>Mann–Whitney test was applied. Bold text indicates that the values reached significant level. **Abbreviations:** NTG, normal-tension glaucoma; POAG, primary open-angle glaucoma; SD, standard deviation; MD, mean difference; CI, confidence interval; df, degree of freedom; RNFL, retina nerve fiber layer.

**Table 4** Comparisons of the optic disc parameters between advanced NTG and POAG (based on clinical assessment)

Optic disc parameters	Mean $\pm$ SD		MD (95% CI)	T stat (df)	P-value*
	Advanced NTG (n=14)	Advanced POAG (n=25)			
Disc area, mm <sup>2</sup>	2.58 $\pm$ 0.42	2.31 $\pm$ 0.37	0.26 (0.00–0.53)	2.02 (37)	0.050
Cup area, mm <sup>2</sup>	1.74 $\pm$ 0.46	1.44 $\pm$ 0.38	0.29 (0.02–0.57)	2.14 (37)	<b>0.039</b>
Rim area, mm <sup>2</sup>	0.84 $\pm$ 0.36	0.87 $\pm$ 0.33	–0.03 (–0.26–0.20)	–0.26 (37)	0.795
Cup volume, mm <sup>3</sup>	0.62 $\pm$ 0.35	0.53 $\pm$ 0.24	0.09 (–0.11–0.28)	0.92 (37)	0.365
Rim volume, mm <sup>3</sup>	0.11 $\pm$ 0.09 <sup>†</sup>	0.13 $\pm$ 0.13 <sup>†</sup>	–	–0.95 <sup>‡</sup>	0.340
Cup/disc area ratio	0.67 $\pm$ 0.13	0.62 $\pm$ 0.13	0.05 (–0.04–0.14)	1.13 (37)	0.264
Linear cup/disc ratio	0.82 $\pm$ 0.08	0.78 $\pm$ 0.08	0.03 (–0.03–0.09)	1.10 (37)	0.277
Mean cup depth, mm	0.36 $\pm$ 0.11	0.39 $\pm$ 0.13	–0.02 (–0.11–0.06)	–0.54 (37)	0.593
Maximum cup depth, mm	0.76 $\pm$ 0.20	0.82 $\pm$ 0.23	–0.06 (–0.21–0.09)	–0.86 (37)	0.393
Cup shape measure	–0.02 $\pm$ 0.07 <sup>†</sup>	–0.06 $\pm$ 0.06 <sup>†</sup>	–	–1.39 <sup>‡</sup>	0.163 <sup>¶</sup>
Height variation contour, mm	0.39 $\pm$ 0.24 <sup>†</sup>	0.30 $\pm$ 0.14 <sup>†</sup>	–	–1.20 <sup>‡</sup>	0.229 <sup>¶</sup>
Mean RNFL thickness, mm	0.10 $\pm$ 0.13 <sup>†</sup>	0.13 $\pm$ 0.10 <sup>†</sup>	–	–1.64 <sup>‡</sup>	0.101 <sup>¶</sup>
RNFL cross-sectional area, mm <sup>2</sup>	0.54 $\pm$ 0.76 <sup>†</sup>	0.70 $\pm$ 0.49 <sup>†</sup>	–	–1.38 <sup>‡</sup>	0.169 <sup>¶</sup>

**Notes:** \*Independent t-test was applied. <sup>†</sup>Median (interquartile range). <sup>‡</sup>Z stat. <sup>¶</sup>Mann–Whitney test was applied. Bold text indicates that the values reached significant level.

**Abbreviations:** NTG, normal-tension glaucoma; POAG, primary open-angle glaucoma; SD, standard deviation; MD, mean difference; CI, confidence interval; df, degree of freedom; RNFL, retina nerve fiber layer.

**Table 5** Comparisons of the optic disc parameters between moderate NTG and POAG patients (based on AGIS score)

Optic disc parameters	Median (interquartile range)		Z stat	P-value*
	Moderate NTG (n=11)	Moderate POAG (n=16)		
Disc area, mm <sup>2</sup>	2.65 (0.72)	2.25 (0.44)	–2.14	<b>0.032</b>
Cup area, mm <sup>2</sup>	1.61 (0.62)	1.22 (0.45)	–1.99	<b>0.047</b>
Rim area, mm <sup>2</sup>	1.03 (0.35)	0.85 (0.50)	–0.25	0.804
Cup volume, mm <sup>3</sup>	0.47 (0.26)	0.33 (0.23)	–0.96	0.340
Rim volume, mm <sup>3</sup>	0.35 (0.23)	0.22 (0.13)	–0.86	0.389
Cup/disc area ratio	0.51 (0.17)	0.53 (0.16)	–1.07	0.284
Linear cup/disc ratio	0.72 (0.11)	0.73 (0.11)	–1.01	0.311
Mean cup depth, mm	0.35 (0.12)	0.30 (0.10)	–0.08	0.939
Maximum cup depth, mm	0.77 (0.27)	0.62 (0.17)	–0.08	0.939
Cup shape measure	–0.04 (0.10)	–0.08 (0.05)	–0.61	0.540
Height variation contour, mm	0.37 (0.10)	0.34 (0.07)	–1.19	0.236
Mean RNFL thickness, mm	0.19 (0.14)	0.16 (0.09)	–1.61	0.108
RNFL cross-sectional area, mm <sup>2</sup>	1.23 (0.79)	0.84 (0.50)	–1.40	0.163

**Notes:** \*Mann–Whitney test was applied. Bold text indicates that the values reached significant level.

**Abbreviations:** NTG, normal-tension glaucoma; POAG, primary open-angle glaucoma; RNFL, retina nerve fiber layer; AGIS, Advanced Glaucoma Intervention Study.

**Table 6** Comparisons of the optic disc parameters between advanced-stage NTG and POAG (based on AGIS score)

Optic disc parameters	Median (interquartile range)		Z stat	P-value*
	Severe NTG (n=11)	Severe POAG (n=22)		
Disc area, mm <sup>2</sup>	2.47 (0.60)	2.28 (0.41)	–2.22	<b>0.026</b>
Cup area, mm <sup>2</sup>	1.66 (0.61)	1.40 (0.57)	–1.58	0.114
Rim area, mm <sup>2</sup>	0.81 (0.34)	0.85 (0.50)	–1.43	0.152
Cup volume, mm <sup>3</sup>	0.63 (0.44)	0.55 (0.45)	–1.80	0.071
Rim volume, mm <sup>3</sup>	0.12 (0.09)	0.13 (0.13)	–1.14	0.256
Cup/disc area ratio	0.67 (0.15)	0.63 (0.20)	–0.07	0.941
Linear cup/disc ratio	0.82 (0.09)	0.80 (0.13)	–0.07	0.941
Mean cup depth, mm	0.36 (0.13)	0.39 (0.24)	–1.78	0.075
Maximum cup depth, mm	0.77 (0.24)	0.83 (0.40)	–1.31	0.191
Cup shape measure	–0.02 (0.07)	–0.05 (0.10)	–1.34	0.180
Height variation contour, mm	0.38 (0.24)	0.32 (0.15)	–0.89	0.373
Mean RNFL thickness, mm	0.09 (0.14)	0.13 (0.10)	–1.29	0.198
RNFL cross-sectional area, mm <sup>2</sup>	0.52 (0.77)	0.70 (0.53)	–1.68	0.093

**Notes:** \*Mann–Whitney test was applied. Bold text indicates that the values reached significant level.

**Abbreviations:** NTG, normal-tension glaucoma; POAG, primary open-angle glaucoma; RNFL, retina nerve fiber layer; AGIS, Advanced Glaucoma Intervention Study.

**Table 7** Comparison of the optic disc parameters between NTG and POAG patients in published articles

Group	Current study, 2014 (Malaysia)		Yang and Park, 1997 (Korea) <sup>26</sup>		Shin et al 2008 (Korea) <sup>27</sup>		Nakatsue et al 2004 (Japan) <sup>28</sup>		Kiriyma et al 2003 (Japan) <sup>28</sup>	
	NTG	POAG	NTG	POAG	NTG	POAG	NTG	POAG	NTG	POAG
Number of subjects, n	32	45	20	23	40	100	60	60	23	17
Mean age ± SD	64.0±9.34	64.9±9.24	55.1±10.6	51.5±11.7	54.3±9.9	52.8±10.5	54.8±13.8	53.2±13.0	59.7±10.2	57.4±9.7
Disc area (mm <sup>2</sup> )	2.65±0.41	2.40±0.36	2.70±0.51	2.22±0.59	2.78±0.48	2.41±0.58	2.40±0.70	2.25±0.42	2.33±0.48	2.23±0.53
Cup area (mm <sup>2</sup> )	1.54±0.43	1.32±0.40	-	-	1.51±0.46	1.11±0.60	1.34±0.59	1.26±0.50	1.46±0.58	1.10±0.55
Rim area (mm <sup>2</sup> )	1.12±0.41	1.07±0.44	1.15±0.27	1.10±0.38	1.27±0.28	1.27±0.33	1.06±0.38	0.99±0.32	0.82±0.21	1.14±0.35
Cup volume (mm <sup>3</sup> )	0.47±0.28	0.40±0.37	0.53±0.33	0.37±0.38	0.47±0.22	0.37±0.30	0.37±0.25	0.41±0.32	0.51±0.35	0.29±0.21
Rim volume (mm <sup>3</sup> )	0.23±0.13	0.21±0.15	-	-	0.27±0.09	0.30±0.15	0.23±0.12	0.21±0.12	0.18±0.10	0.30±0.13
Cup/disc area ratio	0.58±0.14	0.55±0.15	0.56±0.12	0.47±0.22	0.53±0.10	0.45±0.17	0.54±0.15	0.55±0.17	0.63±0.12	0.47±0.17
Mean cup depth (mm)	0.37±0.09	0.35±0.13	0.37±0.13	0.30±0.13	0.36±0.10	0.33±0.12	-	-	0.38±0.13	0.33±0.14
Maximum cup depth (mm)	0.77±0.16	0.75±0.23	0.76±0.19	0.69±0.21	0.77±0.20	0.73±0.19	-	-	0.81±0.22	0.73±0.25
Cup shape measure	-0.04±0.06	-0.06±0.06	-0.04±0.09	-0.11±0.13	-0.06±0.08	-0.09±0.09	-0.06±0.08	-0.07±0.10	-0.06±0.05	-0.09±0.06
Height variation contour (mm)	0.39±0.19	0.33±0.15	-	-	0.34±0.11	0.36±0.11	0.41±0.14	0.39±0.11	0.42±0.16	0.50±0.18
Mean RNFL thickness (mm)	0.15±0.10	0.15±0.08	-	-	0.19±0.07	0.20±0.73	-	-	0.16±0.08	0.25±0.11
RNFL cross sectional area (mm <sup>2</sup> )	0.88±0.60	0.83±0.48	-	-	1.12±0.40	1.09±0.36	-	-	0.83±0.41	1.31±0.62

**Abbreviations:** NTG, normal tension glaucoma; POAG, primary open angle glaucoma; SD, standard deviation; RNFL, retinal nerve fiber layer.

In conclusion, our findings support the existing data on optic disc parameters in NTG and POAG patients from other Asian countries. Our NTG patients had deeper cups and larger optic disc and cup areas in comparison with the POAG patients. These parameters may serve as important optic disc characteristics to differentiate moderate NTG or POAG from the advanced stages of these diseases. However, measurement of IOP and visual field analysis are still the main indicators in clinical practice.

## Disclosure

The authors report no conflict of interest in this work.

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