

Normative Data of Optic Nerve Head in Thai Population by Laser Scanning Tomography: Siriraj Study

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Objective: To study the normative values of topographic optic disc parameters in a Thai population.

Material and Method: Two hundred and six eyes of 103 normal subjects aging from 30-80 years were studied. Thirteen topographic disc parameters were analyzed by confocal scanning laser ophthalmoscope using Heidelberg retina tomography (HRT II). The average value of two eyes in the same subject was used as the unit of statistical analysis, and then the normal values and means were statistically calculated at 95% reference interval (95% RI). Ethnic differences of the calculated optic nerve topography were compared with previous studies. The relationship of age, intraocular pressure (IOP), central corneal thickness (CCT), and optic disc parameters were assessed by Pearson correlation.

Results: Mean values with 95% RI of all 13 parameters were analyzed. Whole parameters except cup volume demonstrated normal distribution. Mean value (95% RI) of disc area in normal Thai people was 2.67 mm² (1.96, 3.71) which was larger than Caucasian people. Ethnic differences in topographic optic disc parameters were found among Thai and other races including Asians, Caucasians, African-Americans, and Hispanics. The results also revealed that age, IOP, and CCT had no significant relation to all optic disc parameters.

Conclusion: Thai people had a larger optic disc area than Caucasians. There are marked differences of topographic optic nerve parameters among different ethnic groups. These differences need to be taken into account when evaluating glaucomatous optic neuropathy and when comparing results of studies completed among population of different ethnic and racial origins.

Keywords: Laser scanning tomography, HRT, Optic nerve head, Disc area, Disc size

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Glaucoma is one of the leading causes of blindness worldwide. It is characterized by retinal ganglion cell death that results in optic nerve damage and visual field loss. Currently, the authors have known that structural change of optic nerve head (ONH) usually precedes functional visual field loss⁽¹⁻³⁾. Therefore, objective evaluation of the optic disc is clinically important in eyes with glaucoma. The Heidelberg Retina Tomograph (HRT II; Heidelberg Engineering, Heidelberg, Germany) is a semi-automated, confocal scanning laser system that provides reliable and reproducible three-dimensional imaging data of the ONH.

To differentiate between normal and glaucomatous optic disc, normative data are required. The appearance of ONH can vary widely. Many reports demonstrated that there were ethnic differences in ONH and emphasized the need for race-specific normal data^(4,5). Previous studies have shown that Afro-Americans have larger optic discs than white people⁽⁴⁻⁸⁾. Tsai et al⁽⁴⁾ found that optic disc area was significantly larger in African-Americans than in Hispanics and Whites, and Asians have optic disc area nearly the same as Afro-Americans. Recent study from China demonstrated that Chinese people have larger disc area than white people by using optic disc photograph⁽⁹⁾. The present study was conducted to establish the normal value of ONH as for the reference in Thai population (Asians) by using HRT II measurement.

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Material and Method

The present study design was a cross-sectional descriptive study. Normal subjects who attended the eye clinic of Siriraj Hospital Bangkok, Thailand, between January 2003 and December 2004 were recruited in the present study. Informed consents were obtained from all participants, and a local research ethics committee approved all methodology.

A detailed medical and ophthalmic history including information on systemic disease, family history of glaucoma, ocular trauma, and ocular surgery were recorded. Subjects were excluded if one of the following conditions was found: intraocular pressure (IOP) ≥ 19 mmHg, history of glaucoma from any cause or on current anti-glaucoma treatment, evidence of uveitis, any disease of optic nerve or retina both congenital and acquired, history of refractive surgery, history of ocular surgery, or trauma.

All subjects completed an ophthalmological examination that included refraction, best corrected visual acuity, Goldmann applannation tonometry, slit-lamp biomicroscopy, fundoscopy, keratometry, pachymetry, and standard white on white automated perimetry (Humphrey 30-2). Inclusion criteria for participants were: Thai people aged between 30-80 years, best corrected visual acuity of 20/40 or better, intraocular pressure (IOP) < 19 mmHg, myopia of < 6 diopter, hyperopia of < 3 diopter, open angles, normal slit-lamp biomicroscopy, and fundoscopy. All subjects also had normal Humphrey visual field testing.

Participants were then imaged with HRT II, with the scanner's focus being adjusted according to the patient's refraction and to obtain the best image. The optic disc contour line in all cases were drawn by one well-trained investigator (NR) to mark the edge of the optic disc using a digital photographic disc image to aid contour placement. HRT II then calculated disc area (square millimeters) and 12 further stereometric parameters. The average value of two eyes in the same subject was used as the unit of statistical analysis, then all 13 optic disc parameters from 103 subjects were statistically analyzed for the mean and standard deviation (SD) values, and 95% reference interval (95% RI). The relationship of age, intraocular pressure (IOP), central corneal thickness (CCT) and 13 optic disc parameters were assessed by Pearson correlation.

Results

One hundred and three normal participants (206 eyes) were included in the study. All participants attended the eye clinic of Siriraj Hospital between

January 2003 and December 2004. There were 90 female (87.4%) and 13 males (12.6%), which was almost the same proportion of the checked up patients in Siriraj Hospital of which 80% were female. The mean values of age, IOP and CCT were 47 year, 13.96 mmHg., and 529.58 μ m respectively (Table 1).

The mean disc area was 2.67 mm² (95% RI: 1.96, 3.71). The mean and 95% RI for all global parameters are presented in Table 2. Global disc area showed a bell-shaped distribution. All parameters, when demonstrated in frequency distribution, they all showed a normal pattern distribution except cup volume. The relationship of age, IOP, CCT, and all parameters of optic disc were assessed by Pearson correlation and the authors found no statistical relationship between age, IOP, CCT, and all topographic optic disc parameters.

Discussion

According to the overlap in ONH parameter ranges between normal and glaucomatous eyes, some

Table 1. The average age, IOP and CCT of 103 normal patients (206 eyes)

	Age (yr)	IOP (mmHg)	CCT (μ m)
Max	79	18.50	632
Min	30	9	459
Mean	47	13.96	529.58
SD	9.95	2.23	32.83

CCT = central corneal thickness, Max = Maximum, Min = minimum, SD = standard deviation

Table 2. Mean, 95% RI of all 13 HRT parameters

	Mean	95% RI	
		Lower	Upper
Disc area (mm ²)	2.674	1.961	3.713
Cup area (mm ²)	0.553	0.036	1.325
Rim area (mm ²)	2.092	1.557	2.749
Cup volume (mm ³)	0.124	0.002	0.408
Rim volume (mm ³)	0.557	0.265	0.964
CD area ratio	0.203	0.018	0.421
Linear CD ratio	0.428	0.096	0.649
Mean cup depth (mm)	0.188	0.074	0.309
Max cup depth (mm)	0.585	0.232	0.969
Cup shape measure	-0.239	-0.379	-0.095
Height variation contour (mm)	0.393	0.256	0.521
Mean RNFL thickness (mm)	0.264	0.167	0.353
RNFL cross-sectional area (mm ²)	1.513	0.874	2.206

previous studies have shown that HRT II has poor sensitivity as a screening modality for glaucoma^(10,11). In contrast, other investigators have shown that HRT can detect optic disc topography abnormalities in glaucoma-suspect eyes before the development of standard achromatic perimetry abnormalities. These data support strongly the importance of optic disc examination for early glaucoma diagnosis⁽¹²⁾. Our study presents the normal range data for ONH parameters measured by HRT II in 206 normal eyes of 103 healthy Thai subjects. Thai people would represent part of an Asian population.

The present study had more females than males (87.4% and 12.6% respectively) because the proportion of the checked up patients in out-patient department, Siriraj Hospital in Bangkok, Thailand, was 80% female. Stephen et al⁽¹³⁾ demonstrated consistent differences in ONH parameters between the sexes. However, the sex-related differences in cup-related parameters did not reach statistical significance. Many studies have also found no significant difference in ONH parameters based on sex⁽¹⁴⁻²⁰⁾. To date, the sex related differences are very small and do not seem to affect the evaluation of optic nerve head in the clinical practice⁽¹⁶⁾.

A recent study found no systematic differences and no clinical important based on laterality or between right and left eye^(16,17). A previous study found conflicting differences in mean retinal nerve fiber layer (RNFL) thickness and cross-sectional area that were clinically minimal⁽¹⁶⁾. Currently, no consistent differences in ONH parameters based on laterality have been demonstrated. The present study used the average values of two eyes in the same subject as the unit of statistical analysis in all topographic optic disc parameters.

All parameters except cup volume showed normal distribution. The authors found that the mean (\pm standard deviation) optic disc area of a normal Thai population was $2.67 \pm 0.03 \text{ mm}^2$. Comparing the values of the presented data to the data from Tsai et al⁽⁴⁾ and other studies^(15,16,21,22) in Table 3, this demonstrated that there were marked differences of topographic optic nerve parameters among different ethnic groups. Interestingly, Thai subjects had a rather large optic disc area, which was 2.67 mm^2 (95% RI: 1.96, 3.71), compared to other ethnic groups. Optic disc area of Thai subjects is larger than Caucasians and Hispanics. When comparing the present data to other studies in an Asian population, Thai subjects also had a larger optic disc area than Japanese⁽²¹⁾ Indians⁽¹⁵⁾. The

Table 3. Comparison between the published literature and our findings for optic nerve head measurements by HRT in normal eyes. Results are shown as mean (SD)

Race of participants	Optic nerve head measurements by HRT in normal eyes									
	Iester et al ⁽²²⁾	Hermann et al ^{(16)*}	Tsai et al ⁽⁴⁾				Nakamura et al ⁽²¹⁾		Agarwal ⁽¹⁵⁾	Presented data
	Whites	Whites	Whites	Hispanics	African-Americans	Asians	Japanese	Indians	Thais	
Number of participants	62	882	30	40	32	29	77	275	103	
Mean age, (years)	48.9 (NA)	46.8 (8.6)	26.83 (5.3)	25.6 (4.5)	27.9 (5.5)	22.6 (4.3)	56 (NA)	42.06 (12.38)	47 (9.95)	
Disc area (mm ²)	2.47 (0.67)	1.83 (0.39)	2.38 (0.05)	2.51 (0.05)	2.65 (0.09)	2.67 (0.10)	2.15 (0.50)	2.34 (0.47)	2.67 (0.03)	
Cup area (mm ²)	0.73 (0.46)	0.44 (0.32)	0.34 (0.06)	0.46 (0.05)	0.63 (0.11)	0.56 (0.10)	0.55 (0.42)	0.63 (0.41)	0.57 (0.03)	
Cup : disc area ratio	0.28 (0.14)	0.22 (0.13)	0.14 (0.02)	0.18 (0.02)	0.22 (0.03)	0.19 (0.03)	0.24 (0.14)	0.25 (0.13)	0.20 (0.01)	
Rim area (mm ²)	1.76 (0.53)	1.39 (0.27)	2.05 (0.06)	2.06 (0.04)	2.02 (0.06)	2.11 (0.07)	1.59 (0.34)	1.72 (0.32)	2.11 (0.02)	
Rim volume (mm ³)	0.49 (0.29)	0.38 (0.13)	0.74 (0.04)	0.68 (0.03)	0.64 (0.05)	0.64 (0.05)	0.44 (0.15)	0.45 (0.15)	0.56 (0.01)	
Mean RNFLT (mm)	0.26 (0.10)	0.263 (0.066)	NA	NA	NA	NA	0.25 (0.080)	0.25 (0.05)	0.26 (0.02)	

RNFLT = retinal nerve fiber layer thickness, NA = not available, * = data from right eye

presented data was similar to data from Tsai et al⁽⁴⁾ that demonstrated that African-Americans and Asians had a larger optic disc area than Caucasians. However, the previous study⁽²³⁾ in Thai population (from the north-eastern part of Thailand) demonstrated that the normal value of disc area was 2.296 mm² (95% RI: 1.586, 3.006). Further study in a larger Thai population will be considered. These differences need to be taken into account when evaluating glaucomatous optic neuropathy and when comparing results of studies completed among populations of different ethnic and racial origins. The current study confirmed and highlighted the growing evidence of the importance for different assessment of the optic nerve head based on optic disc area or optic disc size.

The authors found that there was no statistical relationship between age, IOP, CCT, and all topographic optic disc parameters. Longitudinal studies of normal eyes will help to evaluate change in ONH topography with age. The authors have known that higher IOP is the major risk factor for ganglion cells death and RNFL loss in glaucoma. However, in a normal population, the authors need further study in a larger population to investigate the correlation between IOP (< 20 mmHg.) and RNFL thickness in normal healthy eyes. Association between CCT and RNFL thickness should be further explored in a large population study as well.

In summary, ethnic differences in glaucoma prevalence may be related to differences in IOP, and maybe related to optic disc anatomy and histology. Although, there are studies describing differences in optic nerve head topography between African-Americans and normal white subjects, little is known about the topography of Asian subjects. Therefore, the present study confirmed the need for race specific normative data of topographic optic nerve parameters and encourages further study in a larger population. These results highlight the need to consider race and optic disc size when evaluating the appearance of the optic disc in glaucoma.

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ค่าปกติของหัวประสาทตาในคนไทยจากการถ่ายภาพแนวระนาบโดยเลเซอร์สแกนนิ่ง: การศึกษาในโรงพยาบาลศิริราช

งามแข เวียงวรเวทย์, ชารินันท์ เนื่องต้น

วัตถุประสงค์: เพื่อศึกษาหาค่าปกติของรายละเอียดเฉพาะส่วนต่าง ๆ ของหัวประสาทตาในคนไทย

วัสดุและวิธีการ: ทำการวัดค่าปกติของรายละเอียดเฉพาะส่วนต่าง ๆ ของหัวประสาทตาด้วยเครื่อง Heidelberg Retina Tomography (HRT II) ในอาสาสมัคร 103 คน จำนวน 206 ตา โดยใช้ค่าเฉลี่ยจาก 2 ตา ในอาสาสมัครแต่ละคน มาคำนวณทางสถิติ หาค่ารายละเอียดเฉพาะส่วนของหัวประสาทตาที่วัดได้ 13 ค่า เพื่อหาค่าเฉลี่ย พร้อมทั้งช่วงอ้างอิง 95% โดยเปรียบเทียบความแตกต่างระหว่างค่าที่วัดได้ในคนไทยกับค่าที่วัดได้ในคนเชื้อชาติอื่น ๆ จากรายงานในต่างประเทศ และศึกษาถึงความสัมพันธ์ระหว่าง อายุ ความดันตา ความหนาของกระจกตา และลักษณะรายละเอียดเฉพาะส่วนของหัวประสาทตา โดยวิธี Pearson correlation

ผลการศึกษา: ค่ารายละเอียดเฉพาะส่วนของหัวประสาทตาทั้ง 13 ค่า เมื่อนำมาศึกษาทางสถิติพบว่ามีการแจกแจงแบบปกติ ยกเว้นค่าของ cup volume ค่าเฉลี่ย (ช่วงอ้างอิง 95%) ของ disc area มีค่าเท่ากับ 2.67 ตารางมิลลิเมตร (1.96, 3.71) ซึ่งพบว่ามีความหนาใหญ่กว่าของชาวตะวันตก การศึกษาความสัมพันธ์ระหว่างอายุ ความดันตา และความหนาของกระจกตา พบว่าไม่มีความสัมพันธ์กับค่ารายละเอียดเฉพาะส่วนของหัวประสาทตา

สรุป: พบว่าคนไทยมีขนาดค่าเฉลี่ยของ disc area ที่ใหญ่กว่าชาวตะวันตก ค่ารายละเอียดเฉพาะส่วนของหัวประสาทตา มีความแตกต่างกันในแต่ละเชื้อชาติ ดังนั้น ค่ารายละเอียดเฉพาะส่วนของหัวประสาทตาที่จำเพาะของแต่ละเชื้อชาติจะช่วยให้การวินิจฉัยโรคต้อหินถูกต้องและแม่นยำขึ้น