Optical coherence topography of optic nerve in sample of Iraqi population

Alya Abood Kareem
MBChB, FIBMS, CABMS
University of kufa, faculty of Medicine
Imad Salih Mahdi
MBChB, CABMS
Farooq Mohammed Abbas
MBChB, CABMS

Abstract

Background:
Assessment of optic disc morphology is an important approach for detecting structural damage in patients with glaucoma and many neurological diseases.
Objective:
To determine normal values of optic disc morphology measured by spectral domain optical coherence tomography in a sample in Iraqi population and to correlate the findings with some demographic factors.
Subjects and Method:
A cross sectional study of 324 normal eyes from 162 subject aged (15-75 years) at Ibn Al Haitham teaching eye hospital in Baghdad was conducted to find the optic disc parameters (optic disc area ,average cup disc ratio, vertical disc ratio, rim area) using the Cirrus HD OCT 5000 (Zeiss Inc.).Data were collected and evaluated statistically using the independent T and Chi square tests and a P value of less than 0.05 was considered significant.
Results:
Mean disc area for male was (2.2±0.5 mm^2) while in female was (2.1±0.4 mm^2) , the average cup disc ratio for both male and female was (0.4±0.2) ,the vertical cup disc ratio was (0.5±0.2) for both male and female ,the rim area was (1.5±0.5 mm^2) for male while in female it was (1.4±0.4mm^2) .
Conclusion:
Our study does not deviate largely from other studies .
Intraocular pressure is important factor that affect the disc parameters even with normal range (11-21mm Hg).

Key words: optic nerve , OCT, SD-OCT

Introduction

The optic nerve is that cylindrical structure of approximately 50 mm in length between the retina and optic chiasm .It can be divided into four main divisions:

1. Intraocular (the optic nerve head).
2. Intraorbital (between globe and optic canal).
3. Intracanalicular (within the optic canal).
4. Intracrainial (between optic canal and chiasm). [1]

Optic nerve head (optic disc) is defined as the distal portion of the optic nerve extended from the myelinated portion of nerve that begins just behind the sclera to the retinal surface. Typically it is slightly oval with the vertical diameter being about 9% greater than the horizontal one. It is measuring 1.5 mm horizontally and 1.75 mm vertically; with a cup-shaped depression slightly temporal to its geometric center [2].The optic nerve head can be described in four parts:

1. Superficial nerve fiber layer contiguous with the retinal nerve fiber layer
2. Prelaminar area, consists of nerve fiber bundles and astroglia ,which form sheaths around each bundle.
3. Laminar area, contains a modification of sclera (Lamina Cribrosa).
4. Retrolaminar area, myelinated nerve fibers, circumscribed by leptomeninges of the central nervous system. [3-9]

Optical Coherence Tomography (OCT) is an imaging technique which utilizes the concepts of interferometry as described by Albert Abraham Michelson. The device he designed, later known as an interferometer, sent a single source of white light through a half-silvered mirror that split it into two beams travelling at right angles to one another. After leaving the splitter, the beams travelled out to the ends of long arms where they were reflected back into the middle on small mirrors they then recombined on the far side of the splitter in an eyepiece, producing a pattern of constructive and destructive interference based on the spent time to transit the arms. The use of Optical Coherence in biological systems was described by Huang et al in 1991[10-13].A major event in the evolution of OCT was the use of light wavelengths instead of time delay to determine the spatial location of reflected light. The original OCT method, known as time domain TD-OCT, encoded the location of each reflection in the time information relating the position of a moving reference mirror to the location of the reflection. Spectral domain SD-OCT, instead, acquires all information in a single axial scan through the tissue simultaneously by evaluating the frequency spectrum of the interference between the reflected light and a stationary reference mirror. This method enables much faster acquisition times, resulting in a large increase in the amount of data that can be obtained during a given scan duration using SD-OCT [13-14].

In ophthalmology, the OCT has the following applications:

- The diagnosis and monitoring of macular pathology has been revolutionized by the advent of OCT imaging, e.g. age related macular degeneration, diabetic maculopathy, macular hole, epiretinal membrane and vitreomacular traction, central serous chorioretiniopathy , retinal venous occlusion and retinoschiasis.
- A very useful adjunct to clinical and perimetric assessment in the management of glaucoma, in addition to being used in research in neuroophthalmic diseases.
- Anterior segment OCT has an expanding range of clinical applications such as suspected angle-closure glaucoma and corneal analysis,(pachymetry –pre and post corneal refractive procedures diagnosis and monitoring) [15-19].

OCT has become a routine part of the management of macular and other retinal disease; the same machine can be used for the assessment of glaucoma and has been widely adopted for this

purpose. Sensitivity and specificity utilizing comparison with a normative database are as high as 90%.[20]

The paremeters utilized to study the optic nerve head using the OCT are:

- Peripapillary retinal nerve fiber layer (RNFL) thickness. This involves the acquisition of a circular scan of the retina around the optic nerve head.
- Optic nerve head. Radial cross-sectional scans permit an objective and repeatable assessment of disc morphology, with reasonable discriminatory value. This function has tended to be less commonly used than RNFL analysis in practice.
- Ganglion cell complex (GCC) analysis involves measurement of retinal thickness at the macula to detect early stage glaucomatous damage. Using older time domain OCT, it was found to be regarded as inferior to assessment of other parameters such as peripapillary RNFL assessment; with newer OCT technology interest in GCC analysis has been renewed and it is regarded as comparable and supplementary.
- Progression analysis software has been introduced on several machines, providing a computed assessment of the extent of damage over time presented in graphical form[20-24].

Iraqi population normal data are lacking for that we aimed in this study to determine normal values of optic disc parameters in eyes measured by spectral domian optical coherence tomography (OCT) in a sample of healthy Iraqi population and correlate the findings with some demographic factors.

Subjects and Methods

This is a hospital-based cross sectional study performed by examining randomly selected 324 healthy eyes of 162 normal subjects in outpatient clinics of Ibn Al Haitham teaching eye hospital in Baghdad city from October 2015 till July 2017.

Subjects were 15 years old or older with the following exclusion criteria:

1. A history of ocular hypertension or glaucoma in either eye.
2. A reproducible visual field defect in either eye.
3. Inraocular surgery
4. A deviation from normal refraction by one diopter or more
5. Any contraindication for pupillary dilatation.
6. Evidence of active ocular disease in either eye.
7. Known or suspected neurological disease or systemic diseases that can cause neuropathic changes namely diabetes mellitus, cardiovascular or connective tissue diseases.

Volunteers verbal acceptance for recruitment in this study were taken after discussion of the maneuver and full explanation of the purpose of the study.

Detailed history was taken from all patients including name, age, address, general medical, surgical and drug history. In addition to ophthalmic medical and surgical history.

Complete ophthalmic examination was performed on every candidate before enrollment into the study .Ophthalmic evaluation included refraction , best corrected visual acuity by Snellen chart ,pupil, intraocular pressure measurement with airpuff tonometer, slit lamp biomicroscopy , visual field quantification with the Humphrey Visual Field (HVF) Analyzer using the Swedish Interactive Threshold Algorithm (SITA) Standard 24–2 program(for patients who deviate from the device normal value) , fundus examination with concentration on optic nerve with using lens (condensing lens 90D) after pupillary dilation with 1% tropicamide eye drop. All optic disc measurements were performed using the Cirrus HD OCT 5000 (Zeiss Inc.) .The normal data of reference was taken from Asian race.

Data were collected and evaluated statistically using the independent T and Chi square tests and a P value of less than 0.05 was considered significant.

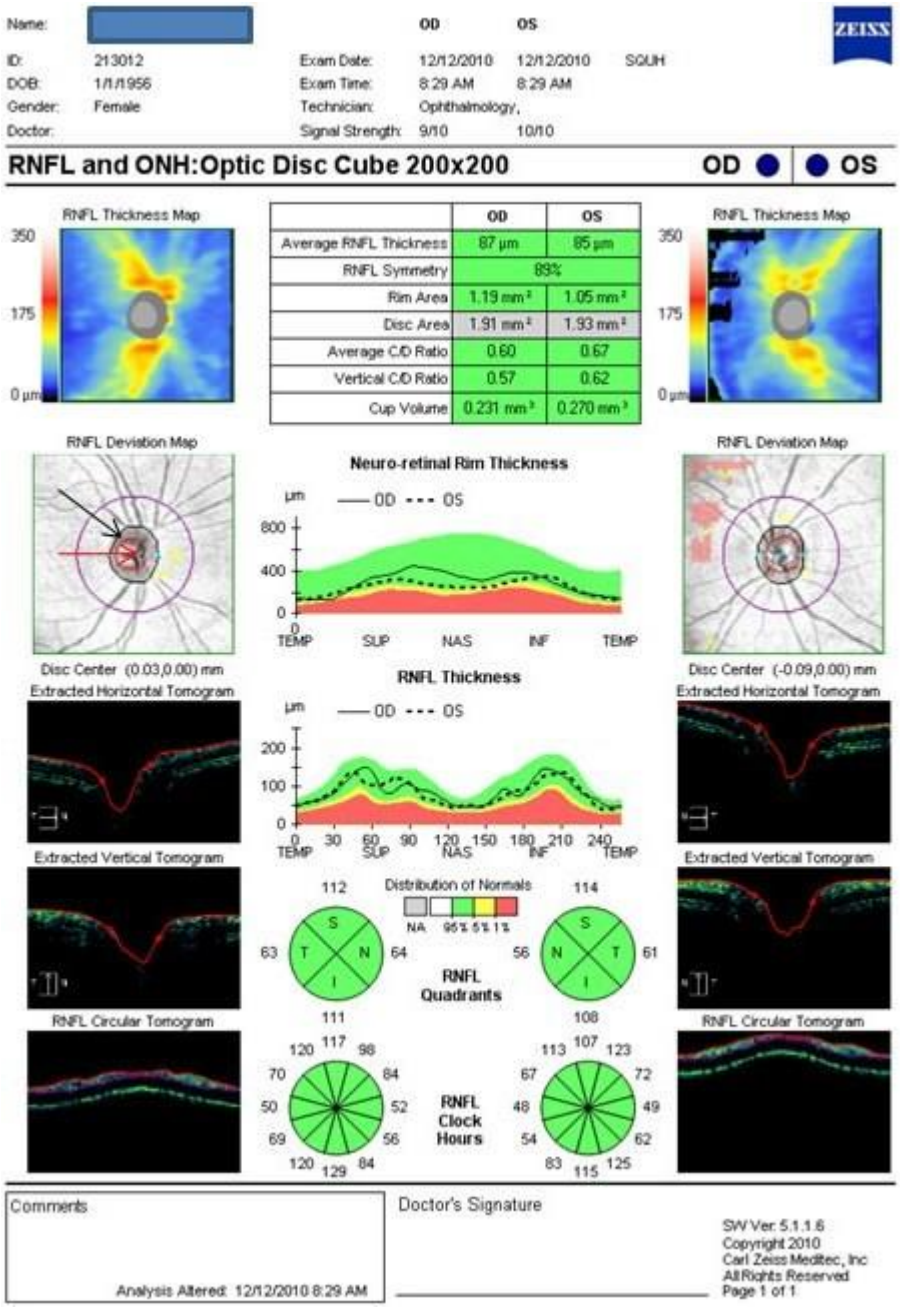

Figure 1

the Cirrus HD OCT 5000 (Zeiss Inc.) Form one of our subjects OCT

Results

Total of three hundred and twenty four eyes of one hundred sixty two subjects were enrolled in this study ,the age was between fifteen years old to seventy fife years, seventy four were male and eighty eight were female ,intraocular pressure in 196 eyes were less than 16 mmHg (60.5%) and 128 eyes were more than 16mm Hg (39.5%).
Demographic characteristic of studied group is shown in table 1

Table 3.1 Demographic characteristic of the studied group.

Variable		**No.**	**%**
Age (years)	less than 20	32	9.9
	20-29	32	9.9
	30-39	90	27.7
	40-49	62	19
	50-59	64	19.8
	60-69	32	9.9
	70 and above	12	3.7
Gender	Male	74	46.6
	Female	88	53.4
IOP in mm Hg	equal or less than 16mm Hg	196	60.5
	more than16mmHg	128	39.5
CDR	less than 0.7	296	91.4
	equal or greater than 0.7	28	8.6

Table 3.2 distribution of eyes according to CD ratio.

CDR	NO.	%
0-0.1	28	8.6
0.11-0.2	36	11.1
0.21-0.3	36	11.1
0.31-0.4	42	13.0
0.41-0.5	57	17.6
0.51-0.6	57	17.6
0.61-0.7	46	14.2
0.71-0.8	22	6.8
Total	324	100

Table 3.3 comparison of mean value and standard deviation of the studied optic disc parameters according to gender.

Variables	Males mean± SD	Females mean± SD	P
Disc area	2.2±0.5	2.1±0.4	0.06
Rim area	1.5±0.5	1.4±0.4	0.1
Vertical CDR	0.5±0.2	0.5±0.2	0.4
CDR	0.4±0.2	0.4±0.2	0.1
IOP	15.5±2.7	15.7±2.7	0.6

Table 3.4 comparison of mean value and standard deviation of the studied optic disc parameters according to IOP.

Variables	IOP≤ 16 mean±SD	IOP> 16 mean±SD	P
Average CDR	0.3±0.2	0.5±0.1	0.0001
Disc area	2.1±0.5	2.2±0.4	0.02
Rim area	1.6±0.5	1.3±0.3	0.0001
Vertical CDR	0.4±0.2	0.6±0.1	0.0001

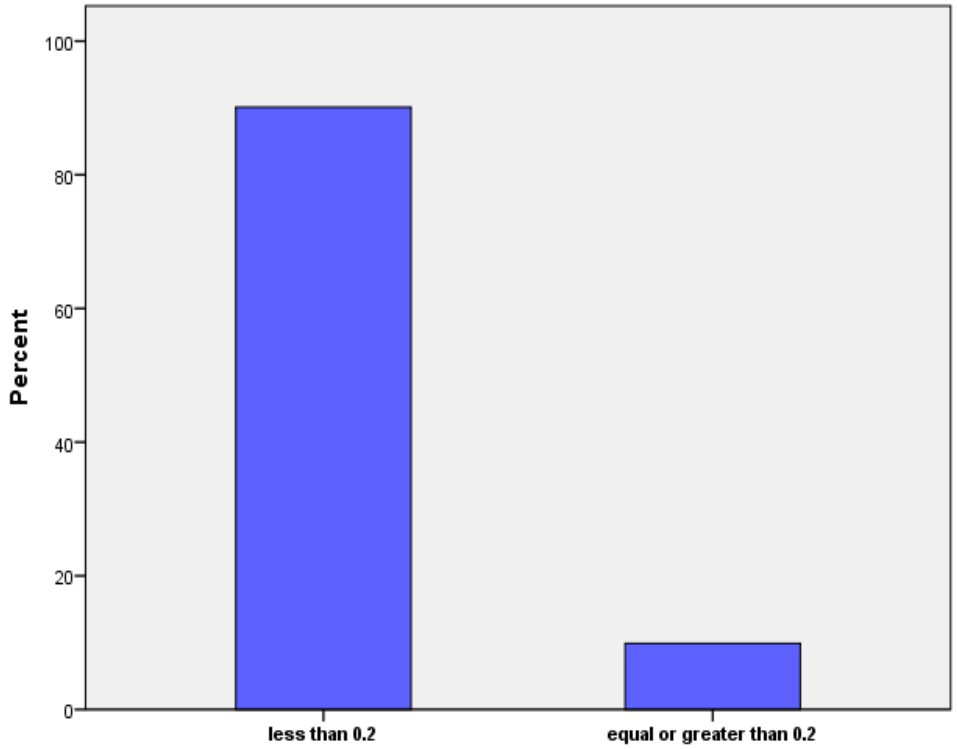

Figure 3.1 distribution of asymmetry in CD ratio between left and right eyes.

Table 3.5 comparison of asymmetry in CD ratio between right and left eyes of same individual with cutoff point 0.2 correlating to gender

	Gender		**Total**	**P**
Difference	**Female NO. (%)**	**Male NO. (%)**		**0.5**
< 0.2	78 (88.6%)	68 (91.9%)	146 (90.1%)	
≥ 0.2	10 (11.4%)	6 (8.1%)	16 (9.9%)	
Total	88 (100%)	74 (100%)	162 (100%)	

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. Table 3.6 CD ratio asymmetry in different age group.

Diff.	**Age group(years)**							**Total**
	< 20 No.(%)	**20-29 No.(%)**	**30-39 No.(%)**	**40-49 No.(%)**	**50-59 No.(%)**	**60-69 No.(%)**	**≥70 No.(%)**	
< 0.2	**15(93.8)**	**15(93.8)**	**43(95.6)**	**28(90.3)**	**28(87.5)**	**14(87.5)**	**3(50)**	**146(90.1)**
≥ 0.2	**1(6.2)**	**1 (6.2)**	**2 (4.4)**	**3(9.7)**	**4(12.5)**	**2 (12.5)**	**3 (50)**	**16(9.9)**
Total	**16(100)**	**16(100)**	**45(100)**	**31(100)**	**32(100)**	**16(100)**	**6(100)**	**162(100)**
P value= 0.04								

Discussion

Abnormality of retinal nerve fiber layer (RNFL) and optic disc changes can occur before onset of detectable visual field loss in some ocular problem such as glaucoma. Optical coherence tomography (OCT) is an imaging modality, which can be used to non-invasively measure retinal optic disc parameters. It is of great use in diagnosis & monitoring of diseases affecting retina and optic nerve .One of the test routinely used to monitor in ocular disease is the optic disc appearance, this test is not dependant on the desire of the patients but on the of clinician. Unlike IOP, the structural parameter does not fluctuate from day to day and unlike visual fields is not dependant on patient cooperation. However, disc evaluation to be of use in patient with optic neuropathy has to be done with great care and attention to detail. Direct examination with a stereoscopic view as obtained with a slit lamp and biconvex 90/78D lens preferably with a dilated pupil is the best method. Optic disc appearance, even in a normal population, is hugely diverse. In the current study variability of optic disc parameter that are usually measured by OCT were studied and the normative data for our population was defined.

Disc area

The mean disc area is ($2.2\pm0.5mm^2$) in male and ($2.1\pm0.4mm^2$) in female which was close to the values found by Barbara C. Marsh and others (2.27±0.41mm2) in a study performed in Indianapolis [25], and that is found in Japan [26] (2.20+_0.55mm2), the result is slightly more than that measured by G Savini et al (2.09+_0.32mm2) in a study perfomed in Italy[27] and lesser than that found by Tharwat H (2.5 +_0.4mm2) in a study performed at Mansoura University [28]. Our results were found to be less than study performed in india ($3.36+\_0.64mm^2$) [29].

The disc area was slightly more in male than female but the P value was not significant .There was a relation between IOP and disc area ,those who have IOP more than 16 mmHg ,have slightly larger disc area as compared to those who have IOP less than 16mm Hg with a significant P value.

Rim area

The calculated rim area was ($1.5\pm0.5mm^2$) in male and (1.4±0.4) in female compared to ($1.67\pm0.33mm^2$), ($1.4\pm0.3mm^2$), and ($1.49\pm0.58mm^2$) in Italy[27], Egypt[28] and India[29] respectively. Differences could be attributed to the different devices used in those studies.Those who have IOP less than 16 mmHg have larger rim area (1.6±0.5) as compared to those who have IOP more than 16 mmHg (1.3±0.3), the P value was highly significant.

Cup disc ratio

The mean CD ratio was found to be (0.4±0.2) which is approximate to the result found in Egypt [28] (0.4±0.1) and slightly more than a study conducted in India (0.29±0.18)[29].

The gender did not affect the CD ratio, but it was higher in those who have IOP more than 16mmHg (0.5±0.1) as compared to those who have IOP less than 16mmHg (0.3±0.2) with a highly significant P value.

In the studied sample 90.1% have less than 0.2 asymmetry in CD ratio and only 9.9% have more than 0.2 asymmetry in CD ratio.

The age affects the asymmetry of CD ratio and it was found that increasing age is associated with a higher prevalence of asymmetrical CD ratio to a statistically significant level.

Vertical CD ratio

The calculated vertical CD ratio is (0.5±0.2). It was (0.5±0.21) , (0.6±0.1) and (0.42±0.18) in India[29] ,Egypt[28] and Italy[27] respectively.

Only 2 out of 324 eyes involved in study had CD ratio of (0.8) and their eyes were completely healthy.

The gender did not affect the ratio significantly but it was higher in those who have IOP than 16mmHg is more than those who have IOP less than 16mmHg.P value was significant.

This study results regarding the vital parameters of optic nerve head as measured by OCT are very close to other comparable studies worldwide and it can be concluded that intraocular pressure is a significant factor that affects the disc parameters even if it is within the normal range (11-21mm Hg).Similarly, advancing age increases the CD ratio asymmetry. Gender does not show a significant effect on the studied parameters.We recommend further studies with larger sample size to strengthen these findings and to add facts about the disc rim area measurements. Additionally, the use of OCT (Cirrus HD OCT 5000 (Zeiss Inc.) with its database to evaluate the optic nerve head is to be encouraged in Iraq because it does not deviate largely from the local population values.

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