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Research Article

Evaluation of Normal Macular Thickness in Healthy Nepali Eyes Using Stratus Domain Optical Coherence Tomography

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Abstract

Aim: To determine the normative values for macular thickness by Optical Coherence Tomography (OCT 3) in healthy Nepalese subjects. **Methods:** Macula of Forty-seven eyes from 47 healthy randomly selected subjects underwent a complete ophthalmologic examination, including OCT. Retinal thickness was automatically calculated by OCT mapping software. OCT parameters of macular thickness were analyzed with baseline variables including age, gender, axial length and refractive error Measurements were displayed as the mean and standard deviation for each of the 9 regions defined in the Early Treatment Diabetic Retinopathy Study. **Results:** Foveal thickness (mean thickness in the central 1000-µm meterdiaarea) on the OCT3 were 210 ± 23. Macular thickness measurements were thinnest at the center of the fovea, thickest within 3-mm diameter of the center, and diminished toward the periphery of the macula. The temporal quadrant was thinner than the nasal quadrant. **Conclusions:** Mean foveal thickness measurements were 34 to 59 µm thicker than previous This discrepancy should be considered when interpreting OCT scans.

Keywords: Macular thickness, SD- OCT

Introduction

Macular edema is a common cause of visual loss. High resolution and reproducible measurement of the macular thickness are needed for both medical and surgical management of macular diseases .Abnormal fluid accumulation within the retina and a concomitant increase in retinal thickness usually result from the breakdown of the blood-retinal barrier. This process can be found in those with diabetic retinopathy, retinal vein occlusion, uveitis, and other ocular disorders. However, it has been observed repeatedly in clinical practice that the presence of macular edema does not necessarily preclude good vision. [1,2]Traditional methods for evaluating macular edema, such as slitlamp biomicroscopy, stereoscopic photography, and fluorescein angiography, are relatively insensitive to small changes in retinal thickness and are qualitative at best The introduction of optical coherence tomography (OCT) has enabled clinicians to reliably detect and measure small changes in macular thickness and to quantitatively evaluate the efficacy of different therapeutic modalities

OCT is a non-invasive non-contact technique which uses near infrared low coherent light passing through a Michelson interferometer to obtain two dimensional images of the retina and optic nerve head.[3]The resolution of OCT 3 is approximately 10 µ and 20 µ in the axial and lateral planes respectively. There are few large studies on the normative data for macular thickness using the OCT. The macular thickness

measurement for diagnostic function may differ with the population used as a database. [4] Thus it is desirable that measurements derived from the normative population be as close as possible to the population for which the instrument is to be used. To the best of our knowledge there is no reported normative database for macular thickness measurement by OCT in normal Nepalese eyes. This study was done to establish the normal macular thickness and volume parameters using OCT 3 in Nepalese eyes

This study measures and defines normal macular thickness values in healthy eyes using OCT3 mapping software. To our knowledge, this is the first study to provide normative macular thickness data for the OCT3 system.

Materials and Methods

Apparently healthy Subjects attending general Ophthalmology clinic of Lumbini Eye Institute Bhairahawa for routine regular screening check up or for various refractive error, presbyopia or dry eyes were included in the study. Patients with known retinal or optic nerve diseases like diabetic retinopathy, glaucoma, Intraocular pressure above 21,abnormal visual field, high refractive error and any past history of intraocular surgery or LASER were excluded. were excluded from the study.The study period was from april 2014 to November 2014. All subjects underwent a complete ophthalmologic examination, including a medical and family history, best-corrected visual acuity testing with Early Treatment Diabetic Retinopathy Study charts, Humphrey SITA standard 24-2 visual field testing, applanation tonometry, slitlamp biomicroscopy, indirect ophthalmoscopy, and color fundus photography. Optical coherence tomograms were acquired through a dilated pupil by an experienced operator using the OCT3 (Carl Zeiss Ophthalmic Systems, HD-Cirrus)

The macular thickness map scan protocol on the OCT3 was used to obtain 6 consecutive macular scans, 6 mm in length, centered on the fovea, at equally spaced angular orientations. The cross-sectional images were analyzed using OCT3 mapping software that used an edge detection technique to locate the strongest 2 edges in each tomogram, presumed to be at the vitreoretinal interface and the anterior surface of the retinal pigment epithelial–choriocapillaris region. Retinal thickness was measured as the distance between these 2 interfaces at each measurement point along the-axis. scan'sBilinearinterpolationx in polar coordinates was used to estimate the thickness of the wedges between each consecutive OCT scan.

We selected the retinal map analysis protocol on the OCT3 to reconstruct a surface map as a false-color topographic image displayed with numeric averages of the measurements for each of the 9 map sectors as defined by the Early Treatment Diabetic Retinopathy Study.[5]

Foveal thickness is defined as the mean thickness within the central 1000-µmdiameter area (the central smallest circle on the Early Treatment Diabetic Retinopathy Study map)

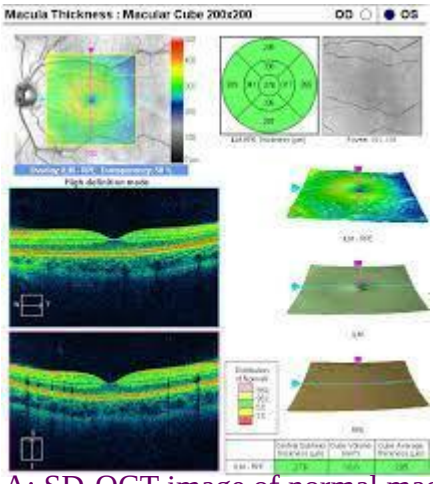

Fig A: SD-OCT image of normal macula

Similarly Normal Macular thickness is divided in 3 concentric rings. The Central ring represent the fovea (500 µm radius or 1 mm diameter), outermost ring represents 6 mm ring. Then each of the middle and outer ring is further measured for 4 sub divided area as superior, nasal ,inferior and temporal quadrant as shown in Figure B below

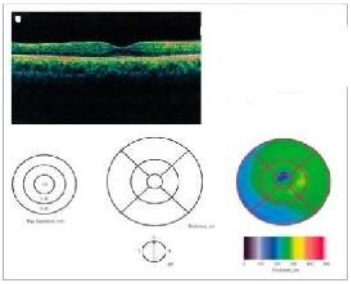

Fig.B showing 3 circles map on macula and sub division of middle and outer ring in 4 quadrant

In addition, the OCT3 mapping software was used to manually locate the minimum value along each radial scan using the raw data. All 6 values were averaged to determine the mean central foveal thickness for each subject. The manually determined central foveal thickness measurements were compared with the values generated by the software, corresponding to the box labeled "Center" on the OCT3 patient prin.

The relationship between foveal thickness and age was investigated using linear regression analysis. Statistical analysis was performed with a commercially available software program (SPSS 11.0.1; SPSS Inc, Chicago, 1ll).

Results

Forrty-seven healthy eyes from 47 healthy subjects were examined clinically and by the OCT3. The patients were aged 20 to 67 years (median, 41 years). There were 34 women (72,3%) and 13 men (27.6%). The mean and standard deviation retinal thickness by sector are shown in and Table 1. The foveal thickness never exceeded 250 µm in any of the ed, healthy macular thickness was thinnest at the center, thickest within 3-mm diameter of the center, and diminished toward the periphery of the macula. The temporal quadrant was thinner than the nasal quadrant. The superior and nasal quadrants were thickest overall. In this study, the inner nasal sector was thickest in 33 patients (70.2%), the inner inferior sector was thickest in 9 patients (19.1.%), the outer superior sector was thickest in 2 patient (4.2%), and the inner superior sector was thickest in 3 patient (6,3%). Macular thickness measurements for a healthy eye population in this study, displayed as the mean and standard deviation in 9 regions, as defined in the Early Treatment Diabetic Retinopathy

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Table 1: Macular thickness in 47 Normal Eyes

Macular region	Retinal thickness in Healthy Eyes,Mean **±SD(µm)**
Fovea(Innermost Circle 500 **µmRadius)**	210±23
Middle ring (1.5-mm radius)	
Superior	245± 14
Inferior	250± 12
Temporal	239± 13
Nasal	265± 17
Outer ring (3-mm radius)	
Superior	236±14
Inferior	207±14
Temporal	210 ± 14
Nasal	254 ± 14

Macular Thickness Measurements in 47 Healthy Eyes Using the OCT3

The standard deviation of the mean thickness of each sector outside the central 1000-µm diameter was consistently approximately 17 µm, demonstrating little measurements by OCT3. The SDs of 20 µmfor mean foveal thickness, were slightly larger.

A summary of previous studies that have measured retinal thickness in healthy eyes using OCT is shown in Table 2 for comparison with this study.

Table 2: Comparison of normal macular thickness in various studies

Study	Number of Eyes	OCT type	Foveal Thickness Innermost ring (1mm Diameter)
Paunescu et al[16]2004	10	OCT 3	204 ± 20
Massin et al,[17]2002	60	Commercial	170 ± 18
Hee et al[18] 1998	73	Prototype	152 ± 21
Schaudig et al,[19] 2000	25	commercial	152 ± 17
Otani et al[20]1999	10	commercial	133 ± 9
Present Study	47	OCT 3	210±23

Discussion

Various modalities used for assessing macular thickness include slitlamp biomicroscopy, stereoscopic fundus photography and fundus fluorescein angiography. Interpretation by all these methods are subjective and semi-quantitative [6].Optical coherence tomography has emerged as a useful imaging technique by providing new high-resolution cross-sectional information about various pathological features of the macula.[7] It allows clinicians to quantitatively measure retinal thickness in a reliable and highly reproducible manner.[8] .OCT has been found to be useful for detecting early diabetic macular abnormalities and in monitoring the effect of laser treatment on macular oedema.[9-10]. Foveal thickness is a strong and independent predictor of clinically significant macular oedema (CSME). [11] Macular thickness changes have shown to be well correlated with changes in visual function and retinal nerve fibre layer (RNFL) structure in glaucoma, OCT macular volumes are said to correlate significantly with glaucoma status. Our results are different from previously published values obtained using earlier versions of the device. In our study, the mean ± SD foveal thickness (average thickness in the central 1000-µm diameter area) was 210 59±µm23thickerµm,approximatthanprevl values.. Clinicians should be aware of these discrepancies when interpreting OCT images from different OCT models. These discrepancies may be a direct result of the greater resolution achieved by the more recent OCT systems. Less movement by the patient because of faster scanning times and more refined algorithms have allowed better image quality. We found that the thickness measurements in the 4 peripheral outer quadrants on the OCT3 were thinner than those reported in the literature.

This may reflect the difference in scan length between the OCT3 and previous versions of the instrument. The 4 outermost zones measured by the OCT3 are thinnest, as expected from histological examination of the eye. In previous reports,[12] the superior and inferior quadrants were thickest, presumably from the superior and inferior arcuate bundling of the nerve fibers. Our findings show that the superior and nasal quadrants were thickest. We identified the nasal quadrant as the thickest region within the central 3-mm diameter. This is consistent with the anatomical relationship of the converging of nerve fibers with the optic disc.

Most of the OCT studies[13] in the literature report central foveal thickness only. Investigators have shown that central foveal thickness is significantly correlated with best-corrected visual acuity in healthy and diabetic eyes. However, foveal thickness may be more indicative of changes in the macula than central foveal thickness for several reasons. Foveal thickness is determined from many more data points than central foveal thickness. For example, each radial scan on the OCT3 is composed of a sequence of 512 A-scans. The macular thickness map scan

protocol uses 6 radial scans per individual. Within the central 1000-µm diameter area thickness is determined from 512 data points, whereas central foveal thickness is determined from only 6 data points.

Brown et al[14] directly compared the clinical gold standard for the detection of macular edema (contact lens biomicroscopy) with the OCT3 for the detection of diabetic foveal edema. Because of the lack of normative data on the OCT3, the study suggested that the cutoff for the upper level of normal foveal thickness be 200stingliteratureµm,.Our based findings do not agree with their assessment. We use 2 SDs to define the cutoffs for the upper and lower levels of normal foveal thickness. Therefore, macular thickening can be suspected if foveal thickness is greater acularthinning than can be suspected 252 if foveal µm thickness and is less than 172 µm when measured with the OCT3. In young man who had a foveal- ged thickness woman who had a foveal of 252 thickness of 154 µm, both exceeding the normal value by can occur and do arise in nearly all experimental data. Patients with subclinical macular thickening or thinning, and other risk factors, may require more frequent follow-up visits. Further OCT studies are needed to investigate whether diabetic patients with subclinical thickening are at higher risk for developing diabetic retinopathy.

Although it has been suspected that macular thickness might decline slightly with age, no statistically significant relationship could be found from this study. These findings are consistent with studies by Hee et al[15]Our study also showed no significant difference in mean foveal thickness between –men212 (209µm) andµm; womenrange,168–24(203144µm)µm; Future studies with larger sample sizes and a more even distribution of men and women may provide more useful information regarding differences by age, sex, and race.

In conclusion, our study provides a normative database for macular thickness using commercially available OCT3 mapping software in Nepalese eyes by Optical Coherence

Tomography. Mean foveal thickness measurements were reported values This discrepancy should be considered when interpreting OCT scans. This could be useful in diagnosis, management and further research in macular disorders and glaucoma.

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