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Macular volume and central foveal thickness measurements in normal eyes of healthy Nigerian adults using optical coherence tomography

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Abstract

Objective: To determine macular volume and central foveal thickness measurements in normal eyes of healthy Nigerian adults using Stratus optical coherence tomography.

Subjects and Methods: Consenting 100 adults Nigerians with normal eyes were recruited and examined using Carl Zeiss Stratus Optical Coherence Tomographer (OCT) machine Model 3000 software version 4.0. A fast macular thickness map scan protocol was employed. Central fovea is defined as locus of intersection of the radial scans. A default setting of six lines at 6 mm was used. Data was analyzed using the paired *t*-test for independence and linear regression.

Results: There were 200 eyes of 100 subjects with mean age of 36.4 ± 11.7 years (M: F = 3.3:1). The mean macula volume was $6.79 \pm 0.392 \mu\text{m}^3$. It was 6.861 ± 0.297 in males, 6.496 ± 0.520 in females and was statistically higher in males than females ($P = 0.000$). The mean central foveal thickness (MCFT) was $149.58 \pm 32.470 \mu\text{m}$. It was $154.49 \pm 34.652 \mu\text{m}$ in males and $133.33 \pm 15.315 \mu\text{m}$ in females. MCFT was significantly higher in males than females ($P = 0.000$).

Conclusion: Normal macular volume and central foveal thickness measurements in Nigerian adults is presented and is comparable to that of Indian and Chinese populations, but lower than reported in Caucasians.

Keywords: Foveal thickness, healthy Nigerian adults, macular volume

Résumé

Objectif: Pour déterminer le volume maculaire et mesures d'épaisseur fovéale central dans les yeux normaux des adultes en bonne santé nigériens à l'aide de la tomographie par cohérence optique de Stratus.

Sujets et Méthodes: Nigériens de 100 adultes consentants avec les yeux normaux ont été recrutés et examinés à l'aide de la version du logiciel machine modèle 3000 Carl Zeiss Stratus Optical cohérence Tomographer (OCT) 4.0. Un protocole d'analyse de carte rapide maculaire épaisseur travaillait. Fovéa centrale est défini comme lieu d'intersection des balayages radiaux. Un paramètre par défaut de six lignes à 6 mm a été utilisé. On a analysé les données à l'aide de la paire *t*-test pour l'indépendance et de la régression linéaire.

Résultats: Il y avait 200 yeux de 100 sujets, avec un âge moyen de $36,4 \pm 11,7$ ans (M:F = 3). Le volume de la macula moyenne était de $6,79 \pm 0,392 \mu\text{m}^3$. Il était $6,861 \pm 0,297$ chez les mâles, $6,496 \pm 0,520$ chez les femelles et était statistiquement plus élevé chez les mâles que les femelles ($P = 0,000$). L'épaisseur moyenne de fovéale central (MCFT) était $149,58 \pm 32,470 \mu\text{m}$. C'était $154,49 \pm 34,652 \mu\text{m}$ chez les mâles et $133,33 \pm 15,315 \mu\text{m}$ chez les femelles. MCFT était significativement plus élevée chez les mâles que les femelles ($P = 0,000$).

Conclusion: Volume maculaire normal et des mesures d'épaisseur centrale centrale chez l'adulte nigérien est présentée et est comparable à celle des populations indiennes et chinoises, mais plus bas que ceux rapportés chez les Caucasiens.

Mots-clés: Épaisseur fovéale, adultes en bonne santé nigériens, volume maculaire

Introduction

There are various ways of evaluating the state of the retina and making relevant observations such as fundal fluorescein angiography (FFA), Indocyanin Green angiography (IGA), fundal photography, and ultrasonography. Optical coherence tomography (OCT) provides a new dimension in the diagnosis, management, and understanding of the pathogenesis of retinal diseases. OCT is a non-invasive, non-contact technology capable of providing “optical biopsy” imaging at or near the resolution of histopathology without excisional biopsy.^[1] It is a new technique for high resolution cross-sectional visualization of retinal structure.^[2] OCT works based on the principle of Michelson Interferometry. Low coherence infrared light coupled to a fiber optic travels to a beam splitter and directed through the ocular media to the retina and to a reference mirror, respectively. Light passing through the eye is reflected by structures in different retinal tissue layers. The distance between the beam splitter and mirror is continuously varied. When the distance between the light source and the retinal tissue is equal to the distance between the light source and reference mirror, the reflected light from the retinal tissue and reference mirror interact to produce an interference pattern. The interference pattern is detected and processed into a signal.^[3,4] Resolution of retinal structure by OCT depends on the contrast in relative reflectivity of adjacent structures.^[5] Total macula volume (TMV) and foveal thickness (FT) measurements are important in evaluation and monitoring of macular diseases such as diabetic macula edema, cystoids maculopathy, Age Related Macula Degeneration (ARMD), and impact of retinal vascular occlusion.^[6] Normative data on macula volume and foveal thickness is essential in providing a reference for comparison with findings in disease situations. The aim of the study was to determine the macula volume and central foveal thickness using the Stratus-OCT in normal eyes of healthy Nigerian adults.

Subjects and Methods

The study adhered to the tenets of the Helsinki Declaration. Ethical approval was obtained from the Ethics Review Board of Aminu Kano Teaching Hospital in 2011. One hundred subjects were recruited into the study after administration and acceptance of informed consent. This mainly comprised of patients with minor non-sight involving complaints. Criteria for recruitment include 20/20 unaided visual acuity, normal findings on basic eye examination, and normal intra-ocular pressure measured with Keeler Pulse air non-contact tonometer. Subjects who were known to have

diabetes mellitus, systemic hypertension, and smoke cigarette or had previous eye surgery due to any cause were excluded as well as subjects with existing ocular morbidity. Carl Zeiss Stratus OCT machine Model 3000 software version 4.0 was used. The procedure was explained to the subjects in detail. The macula was scanned after adjustment with “Normalize” and “Align” protocols. Fast macular thickness map scan protocols consisting of 6–24 equally spaced line scans were employed. All the lines passed through a central common axis centered on the fovea. Central fovea was defined as locus of intersection of the radial scans. A default setting of six lines at 6 mm was used. Both eyes were scanned. The system has an inbuilt algorithm to generate the measured parameters. The findings were saved on the system and printed copies made for reference. Data was analyzed using the paired *t*-test for independence and linear regression.

Results

There were 200 eyes of 100 subjects comprising 77 males and 23 females (M:F = 3.3:1). The subject's ages ranged between 18 years and 48 years with mean age of 36.4 ± 11.7 years. The mean macula volume was $6.79 \pm 0.392 \mu\text{m}^3$. Mean macula volume was $6.861 \pm 0.297 \mu\text{m}^3$ in males and $6.496 \pm 0.520 \mu\text{m}^3$ in females. Macula volume was statistically higher in males than females ($P = 0.000$). The mean macula volume was 6.79 ± 0.404 in the right eye and $6.79 \pm 0.382 \mu\text{m}^3$ in the left. There was no statistically significant difference in macula volume between the right and left eyes ($P = 0.747$). The mean central foveal thickness (MCFT) was $149.58 \pm 32.470 \mu\text{m}$. In males, MCFT was $154.49 \pm 34.652 \mu\text{m}$ and $133.33 \pm 15.315 \mu\text{m}$ in females. The MCFT was significantly higher in males than females ($P = 0.000$). Mean central foveal thickness was similar with no significant difference between the right and left eyes ($P = 0.984$).

Discussion

Normative data is essential in interpreting OCT macula parameters to detect abnormalities in disease situations such as diabetic macula edema, retinal vein occlusion, and toxic maculopathies. OCT is more accurate than conventional methods of measuring macula edema such as slit lamp biomicroscopy and stereoscopic photography.^[7] Visual reduction is correlated to macular thickening in diabetic macula edema.^[8] The Handan Eye Study in China reported macular volume of 6.761 ± 0.516 and this is comparable to our finding.^[9] Some studies reported lower mean macular volume of 6.41 ± 0.35 , and 5.411 ± 2.017 , respectively.^[10,11] The MCFT we

observed is comparable to the Handan Eye Study which reported MCFT of 150.3, and the study in India, whereby the MCFT in 170 consecutive normal eyes was 149.16 ± 21.15 .^[9,11] Two studies in Taiwan showed variation in observed MCFT. In one study, the MCFT was 195 ± 26 .^[10] In the other study of 52 eyes of 52 subjects (32 males and 20 females), the MCFT was 252.8.^[12] In Japan, MCFT was 222 ± 19 .^[13] In Boston, a study of 37 eyes from 37 healthy subjects reported a MCFT of 182.23.^[7] These studies showed a higher central foveal thickness than we observed. The higher MCFT reported in these studies may be race related. Some studies have shown that African Americans have significantly thinner central foveal thickness than their age matched Caucasians.^[14] Our MCFT finding seems to be comparable with the report of the study of the Indian population. Similar to the study in Japan, we observed significant difference in MCFT in males compared to females,^[13] and this trend has been reported in other studies.^[15,16] Women

are reported to have significantly thinner retina than men.^[17] The study in India showed no significant difference by gender ($P = 0.23$).^[11] Difference between the sexes and races is well documented with black women having the thinnest retina.^[14] Other studies were silent on gender difference in MCFT.^[10,11,13,17] There was no correlation between age and MCFT in the Japanese study,^[13] unlike the study in India, that showed a strong positive relationship ($P = 0.002$).^[11] Our study was conducted on relatively young subjects and did not analyze the relationship between age and MCFT. Similarly, other studies did not comment on the correlation of age with MFCT.^[7,9,10,17,18] We did not observe any difference in either mean macular volume or central foveal thickness between the right and left eyes. Most studies were on single eyes of selected subjects and made no comparison between the two sides.^[7,10,11,17,18] This is probably due to similarity in observed measurements in both eyes. Race and sex differences may be the

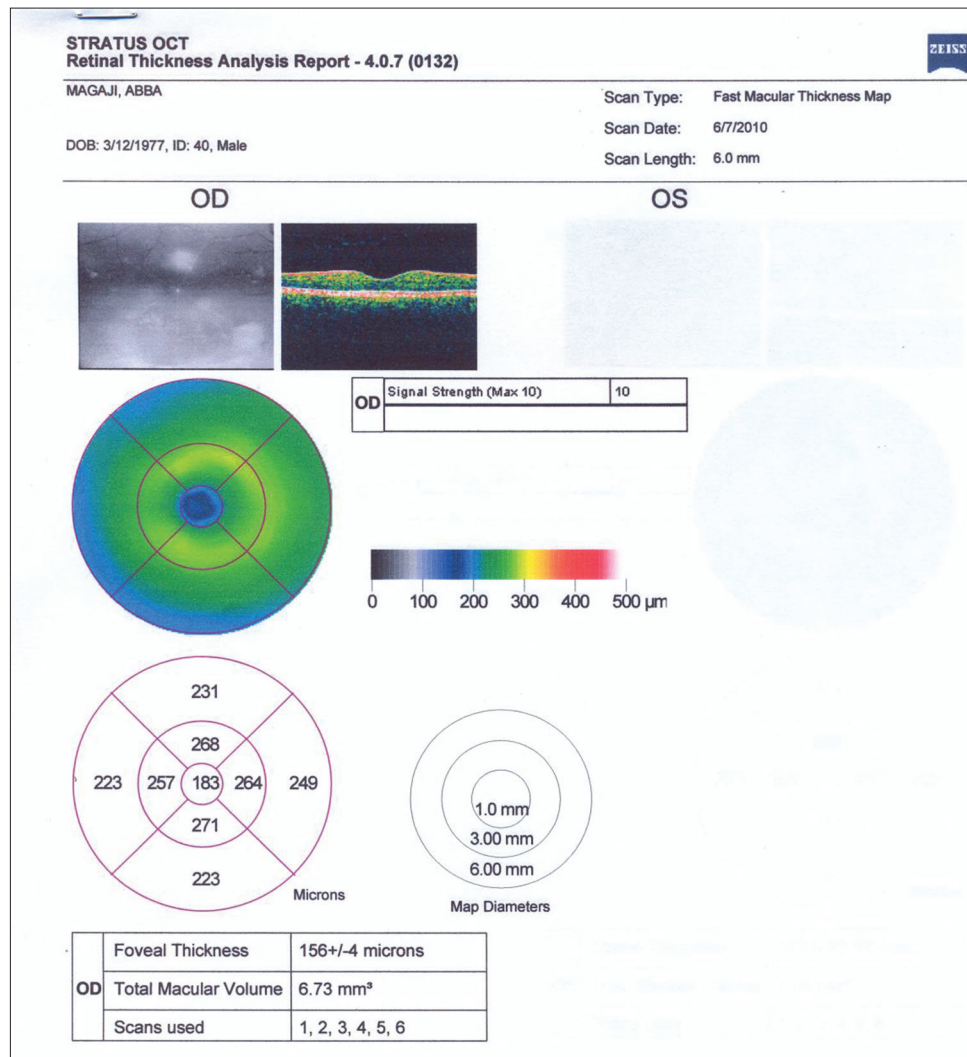


Figure 1: Normal macula scan

mechanism explaining variation in central foveal thickness and macular volume in the Nigerian subjects studied. A study may have to be conducted to provide possible explanation for the reason in the difference in macular volume and foveal thickness measurements between Africans, Asians, and Caucasians. All the studies discussed are based on measurements obtained with the Stratus OCT model similar to the one we used in this study. This is necessary to enable us make comparison on the results as thickness measurements are not interchangeable between different OCT devices and results vary with different models.^[19] A normal macular scan is illustrated in Figure 1. The macular volume and central foveal thickness measurements in Nigerian adults is presented for reference and to aid in objective decision making in patients with macular disease. The subjects studied are all of Hausa ethnic origin. As there are over 250 ethnic groups in Nigeria more studies need to be carried out to determine, if there are variations in results among different ethnic identities. Time Domain OCT is more accurate and has faster acquisition time; this machine is not available in our institution. Normal macular volume and central foveal thickness measurements in Nigerian adults is presented and is comparable to that of Indian and Chinese populations, but lower than reported in Caucasians.

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