Original Article

MACULA IN UVEITIS PATIENTS: AN OPTICAL COHERANCE TOMOGRAPHY STUDY

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ARTICLE INFO

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Received:
Apr 2019
Accepted for publication:
June 2019

Keywords:

OCT
Uveitis
Macula edema
Cystoid macula edema
Epiretinal membrane

ABSTRACT

A research was conducted to study the morphology of the macula in eyes of uveitis patients using Optical Coherence Tomography (OCT). Objectives of the study were to describe the morphological characteristic of the macula in uveitis patients using the OCT and to assess the correlation between the foveal thickness and visual acuity. A cross sectional study involving uveitis patients attending the uveitis clinic in Universiti Kebangsaan Malaysia Medical Center. Data collected include age, gender, types of uveitis, visual acuity, macula thickness as measured by the OCT, and fundus photograph. A total of 88 eyes from 88 patients were included in the analysis. Slightly more than half of the eyes (n=47, 53.3%) had no macula edema (ME). Out of the 18.2% of eyes with macula edema, 12.5% had cystoid macula edema (CME) and 5.7% had diffuse macula edema (DME). The remaining 28.4% had epiretinal membrane. There was no statistical difference between subjects with and without ME in terms of age, gender and ethnicity. While ME is present in approximately 20% of eyes with uveitis, there is no correlation between visual acuity and foveal thickness. Poor vision in uveitis has to be accounted for by other causes such as cataract, vitritis and secondary glaucoma.

INTRODUCTION

Uveitis is a leading cause of ocular morbidity in the United States [1]. The causes of visual loss in uveitis patients are numerous. Complications such as cataracts, cystoid macular edema and glaucoma are among the leading causes of reduced vision [2].

Classification and standardization of uveitis is important as it enhances the comparability of clinical research from different centers. There were various classification criteria and inflammation grading scheme as well as outcomes criteria [1,3].

Uveitis may occur with or without accompanying vitritis, retinitis, papillitis, or optic neuritis. Uveitis is classified anatomically as anterior, intermediate, posterior or panuveitis according to International Uveitis Study Group [4].

Macula, a small, oval-shaped, highly pigmented area at the center of the human retina is responsible for central vision. This central 5% of the retina is most critical for vision. The densely packed photoreceptors in the macula control all of the eye's central vision and are responsible for the ability to read, drive a car, watch television, see faces and distinguish details.

Macular edema is the swelling of the macula characterized by an increase in macula thickness caused by fluid leaking from the retinal blood vessels into the macula. Macular edema is the most common macular changes and visual loss associated with uveitis. The abnormal fluid accumulation within the neurosensory retina usually results from the break-down of the inner blood-retinal barrier [3].

Optical Coherence Tomography (OCT) is a non-invasive technology for imaging the multi-layered sensory tissue lining the back of the eye. It is commonly used to image lesions of the macula, such as macular thickening in diabetic macular edema [5,6,7]. Currently OCT is an ophthalmic technology that has been used to image a multitude of retinal diseases. Macular lesion associated with optic nerve head pits, epiretinal membranes, central serous chorioretinopathy, age-related macular degeneration, choroidal neovascularization, diabetic macular edema and uveitis are some of the diseases that have been studied using the OCT [8,9].

The ability of OCT to provide quantitative measure-ment makes it complimentary to traditional means of examination by ophthalmoscope and slit lamp biomicroscopy [3]. Optical Coherence Tomography

was found to be in good agreement with the clinical gold standard (slit lamp examination through a dilated pupil) for detecting the presence or absence of macular edema and was found to be more sensitive in cases of mild foveal thickening [8].

The introduction of OCT has enabled clinicians to reliably detect and measure small changes in macular thickness and to quantitatively evaluate the efficacy of different therapeutic modality [5,10,11]. It has emerged as a useful imaging technique by providing new high-resolution cross-sectional information about various pathology of the macula [7]. It also allows clinicians to quantitatively measure macular thickness in a reliable and highly reproducible manner.

The advantage of OCT imaging is its high resolution, which is on the order of 10 to 15 mm axial direction [11]. Optical Coherent Tomography has been demonstrated to be a valuable technique for the detection and the monitoring of a variety of macular disease in uveitis [5,7].

This study measured and defined macular thickness values in uveitic eyes using OCT mapping software, which is now proven to be an effective non-invasive investigation in detecting macular morphology in uveitis and is an important ancillary investigation at the time of initial diagnosis [11]. The measurements can be repeated safely during follow-up to monitor response to any intervention and treatments (6).

We studied the morphological characteristics of uveitic macula by the OCT and the correlation between the foveal thickness and visual acuity among various types of uveitis.

MATERIAL AND METHODS

This was a hospital based cross-sectional study conducted between December 2009 and May 2010 involving patients diagnosed with uveitis attending the uveitis clinic in University Kebangsaan Malaysia Medical Center (UKMMC).

One eye per patient was selected. Inclusion criteria were consented uveitic patients, clear media for a good fundus photography and good OCT signal strength of more than four. Patients with poorly dilated pupil and media opacity precluding a good OCT image were excluded. Ethical approval was obtained from the Research and Ethics Committee, Faculty of Medicine, Universiti Kebangsaan Malaysia. Written consent was obtained from all participants prior to participation in this study.

Uveitis was classified as below:

Anterior uveitis : affecting the anterior of the eye, mainly the area around the iris.

Intermediate uveitis: affecting the area around the anterior end of the retina and the vitreous.
Posterior uveitis: affecting the posterior portion of the eye including the retina and optic nerve.
Panuveitis: affecting at least two of the disease forms described above.

The mean foveal thickness measurement with OCT is considered to represent the macular as it is the best discriminator between eyes with or without macular morphology such as macular edema. Macular edema is present when the mean retinal thickness at the central fovea was more than 333+171mm [12].

The Optical Coherence Tomography (OCT)
Stratus OCT with a 2 mm deep, 6 mm wide image was used for macular imaging. Imaging was performed at two different transverse scan densities: standard density (high-speed acquisition) and high density (lower-speed acquisition). For each session, the scan alignment was be guided by the fundus image provided by the OCT system. The OCT did not allow additional alignment between visits. The macular scan is composed of six linear scans centered at the fovea equally spaced 30° apart. The entire standard scan types for the fast speed acquisition were attained simultaneously. The OCT images were automatically analyzed with the Stratus OCT software and quantitatively measured the macula thickness by segments [13].

Upon dilatation of the pupils using Guttae Mydriacyl 1% and Phenylephrine 2.5%, macular thickness measurement were obtained using the Stratus Optical Coherence Tomography model 3000. Macular scans consisted of six 6-mm linear radial scans through the foveal in a spoke-like configuration, with each line 30 degrees apart. The macular scan gave average macular thickness values of 9 zones, the inner macular thickness in superior, inferior, nasal and temporal quadrants in μm; and outer macular thickness in the superior, inferior, nasal and temporal quadrants in μm (Figure 1).

Finally, fundus photograph was taken for each subject for photographic documentation using the Topcon TRC 50DX retinal camera.

Visual acuity (VA):
Visual Acuity is the acuteness or clearness of vision. In this study, Snellen chart was used to determine visual acuity. The Snellen acuities were converted to a LogMar scale (Table 1).

Data were analysed using SPSS version 16.0. The value of $p<0.05$ was considered as significant. Data were checked for its normal distribution with histogram, skewness and kurtosis test and Kolmogrove-smirnov test. Spearman's Rank Order Correlation was used to examine the relationship between foveal thickness and visual acuity.

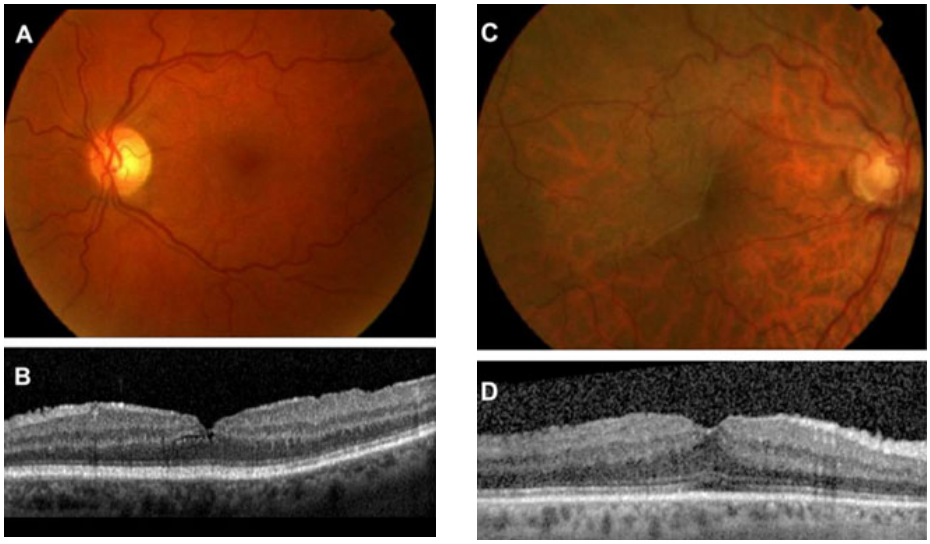

Figure. 1: **A** is Fundus with mild macula edema and **C** the corresponding OCT. **B** is the macula edema with epiretinal membrane and **D** the corresponding OCT.

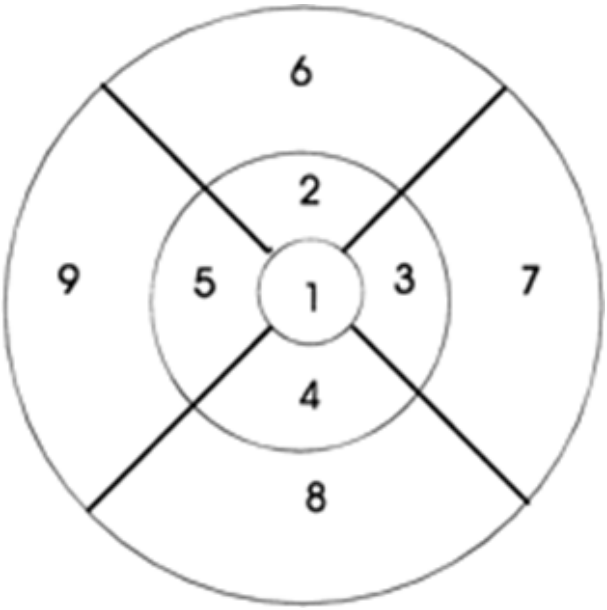

Figure 2: OCT scan of the macula in 9 zones

Table 1: Conversion chart: Snellen verses LogMar.

Snellen (m)	**LogMar**
6/3	-0.3
6/4	-0.2
6/5	-0.1
6/6	0
6/9	0.2
6/12	0.3
6/18	0.5
6/24	0.6
6/36	0.8

RESULTS

Demographic Data

A total of 88 patients were eligible for the study (Table 2). Patients aged 30 - 44-years-old formed the highest number, 31 of 88 eyes(35.2%), followed by the age group 45 – 59-years-old, 21.6%.
Anterior and intermediate uveitis formed the two most common types of uveitis , 36.4% and 34.1% respectively, followed by panuveitis (17%) and posterior uveitis (12.5%).

Morphologic Characteristic of Uveitic Macular

We found 41 out of 88 patients (46.6%) had macular changes (Table 3). There were 3 patterns of macular thickening identified in this study: cystoids macular edema (CME) (11 eyes, 12.5%) diffuse macular edema (DME) (5 eyes, 5.7%) and epiretinal membrane (ERM) (25 eyes, 28.4%).

Table 4 showed characteristics of subjects with and without macula changes. There was no statistically significant difference between the groups with and without macula changes in term of gender,age and ethnicity ($p>0.005$).

The Correlation between Foveal Thickness and Visual Acuity Among Various Classification of Uveitis

To study the relationship between two entities, we used Spearman correlation as both data were not normally distributed. There was no statistically significant correlation between the foveal thickness and visual acuity within eyes with or without macula changes (Table 5, Figure 3, 4).

Classification of uveitis among age group was showed in Figure 5.

Table 2: Demographic characteristic of the study population.

CHARACTERISTICS	PATIENTS (n)	%
AGE GROUP		
0-14	1	1.1
15-29	22	25
30-44	31	35.2
45-59	19	21.6
>60	15	17
GENDER		
Male	47	53.4
Female	41	46.6
RACE		
Malay	50	56.8
Chinese	33	37.5
Indian	5	5.7
UVEITIS CLASSIFICATION		
Anterior	32	36.4
Intermediate	30	34.1
Posterior	11	12.5
Panuveitis	15	17.0

Table 3: Morphologic characteristic of the macula in the study population.

MACULAR CHANGES	PATIENTS (n)	%
No changes	47	53.4
Cystoid macular edema	11	12.5
Diffuse macular edema	5	5.7
Epiretinal membrane	25	28.4

Table 4: Characteristics of subjects with and without macula changes.

CHARACTERISTICS	NO MACULAR CHANGEs	WITH MACULAR CHANGES	p value
Eyes, n(88)	47	41	
Age Mean	39.55±15.376	43.07±16.837	0.315[a]
Gender Male Female	25 22	22 19	0.96 [a]
Race Malay Chinese Indian	27 (54.7%) 17 (36.2%) 3 (6.4%)	21 (51.2%) 17 (41.5%) 3 (7.3%)	0.843 [a]

[a] Chi-Square test

Table 5: Correlation between foveal thickness and visual acuity.

	No macular changes	With macular changes
Correlation coefficient	0.269	-0.178
p value	0.067	0.266

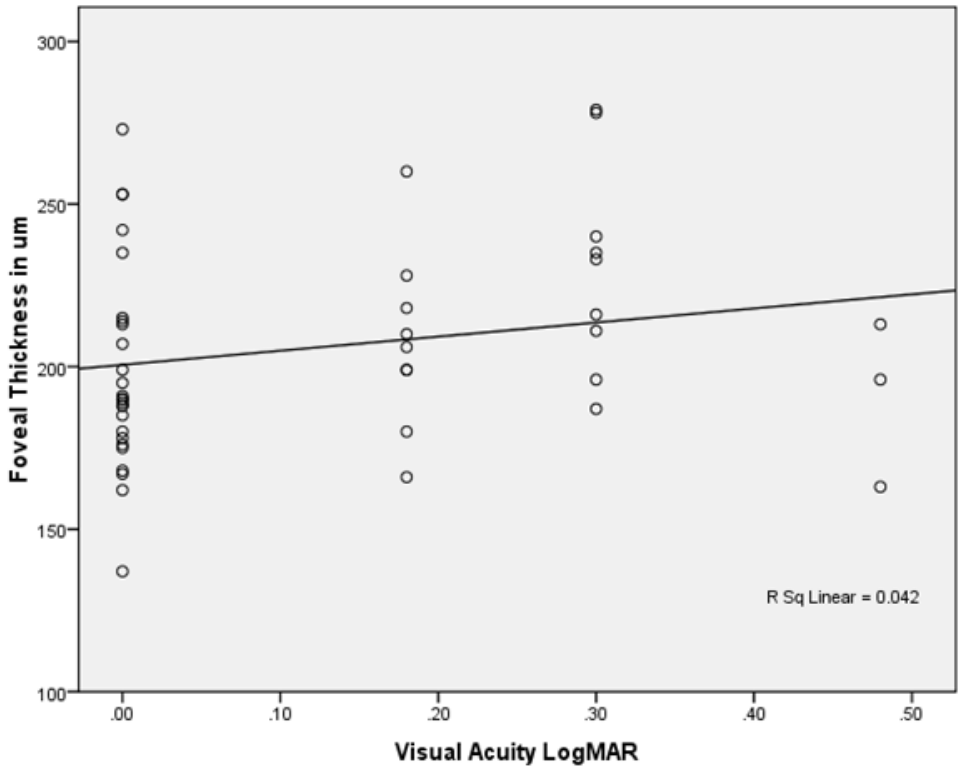

Figure 3: Correlation between foveal thickness and visual acuity in eyes with no macular changes.

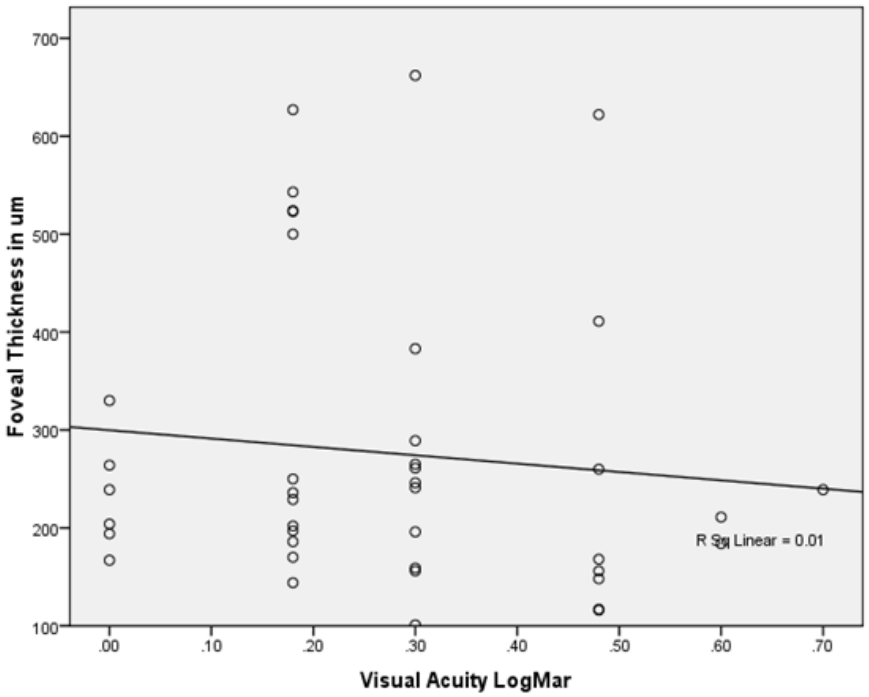

Figure 4: Correlation between foveal thickness and visual acuity in eyes with macular changes.

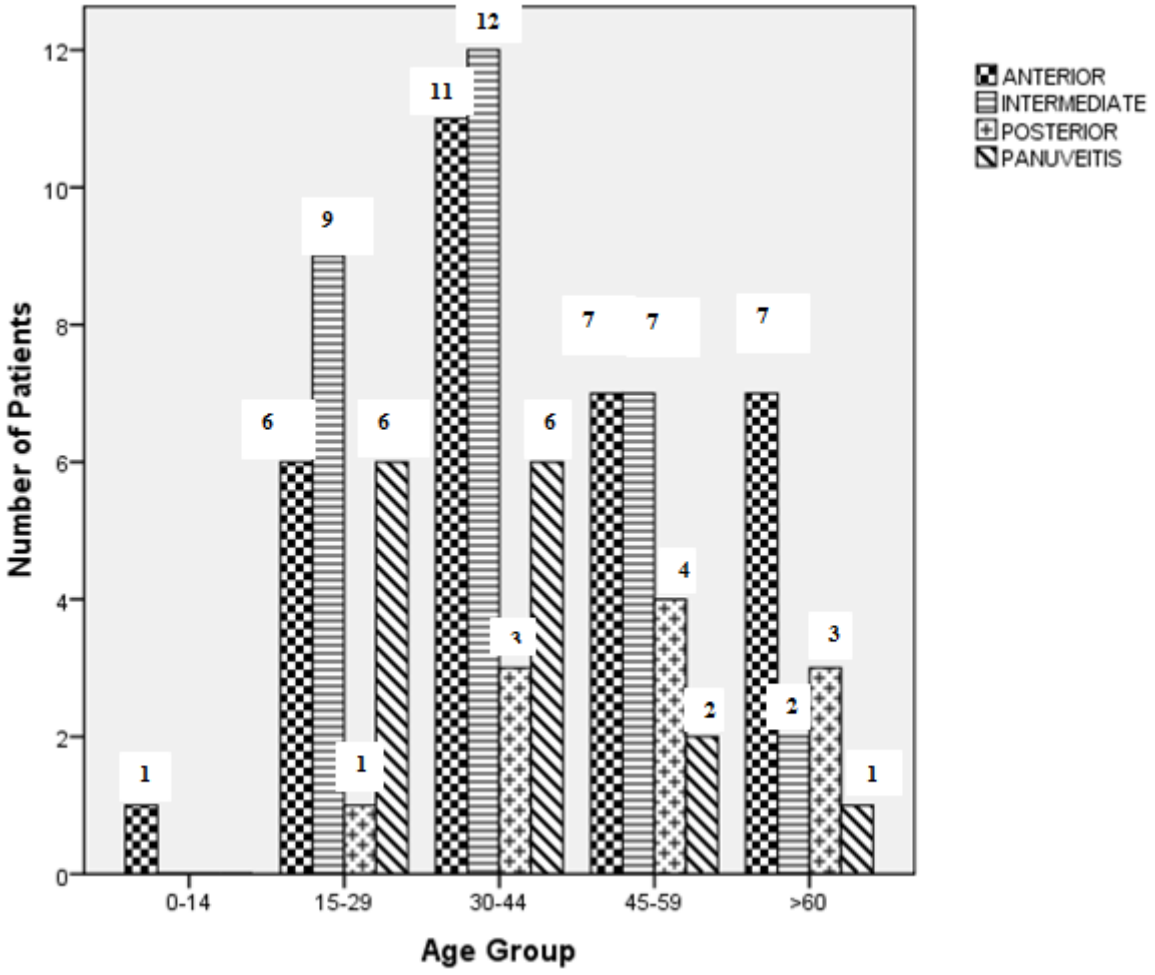

Figure 5: Classification of uveitis distribution among age groups.

DISCUSSIONS

Uveitis is one of a leading cause of ocular morbidity in the United States according to 2001 study by Rhett et al, although population-based estimates of its true incidence and prevalence are not available [1].

Application of Optical Coherence Tomography (OCT) as an imaging modality for non-invasive cross-sectional imaging of the biological tissues was first reported in 1991 by Huang et al [13]. Since its development in 1991, OCT has been investigated in a wide range of clinical applications. This helps in interpretation of pathology in the context of its anatomic location, substantiating the diagnosis, monitoring the course of the disease and evaluating the response therapeutic intervention [4].

The age and gender distribution of patients in this study compares well to other studies, with majority of the patients in the age group 30 – 45 years-old and almost equal male and female proportion [14].

The racial breakdown of uveitic patients was found to be interestingly similar to the racial breakdown of the Malaysia population, according to the population census done in 2000 (65% Malays, 26% Chinese, 7% Indian and 2% others) [14]. This finding may suggest that this disease affects the races equally and has no predilection for any one race in particular.

According to the anatomical classification of uveitis (IUSG) , in our study we found 36.4% (32 eyes) anterior uveitis followed by intermediate uveitis, 34.1% (30 eyes), posterior 2.5% (11 eyes) and panuveitis 17.0% (15 eyes). The similar distribution is seen in study done by Das et al in 2009 [13,15].

In this study, 46.6%, that is 41 out of 88 eyes, had macular changes. Optical Coherence Tomography revealed 3 patterns of macular thickening, CME was detected in 11 eyes(12.5%) and DME in 5 eyes, (5.7%) and ERM in 25 eyes (28.4%). Markomichelakis et al in 2007 described three patterns of macular edema: Cystoid Macular Edema (CME), Diffuse Macular Edema (DME) and Retinal Detachment (RD) however we observed CME, DME and ERM with no evidence of RD [12].

Unlike other studies we found no correlation between foveal thickness and visual acuity in both groups, with no macular changes (r=0.269, p= 0.067) and with macular changes (r = -0.178, p=0.266) [16]. This is probably due various stages of uveitis recruited in our study and other causes of reduced vision such as cataract, vitritis and secondary glaucoma which is beyond the scope of this study [17].

CONCLUSION

Morphological characteristics of macula in uveitis found in this study by OCT are cystoids macular edema (CME), diffuse macular edema (DME) and epiretinal membrane (ERM). There is no correlation between foveal thickness and visual acuity in eyes with and without macular changes. Majority of cases were in the age group 30-44 years-old with Intermediate uveitis being the most prevalent.

FINANCIAL SUPPORT

This study was funded by the Universiti Kebangsaan Malaysia.

CONFLICT OF INTEREST

No conflict of interest exists for any of the authors

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