# Assessment of the Morphology of Diabetic Macular Edema Using Optical Coherence Tomography

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## Abstract

**Background**: Diabetic macular edema(DME) is a major cause of visual loss in patients with diabetes. It usually results from the breakdown of the inner blood–retinal barrier. Early detection of retinal abnormalities is vital in preventing diabetic macular edema and subsequent loss of vision. Until recently, the methods available for detecting and evaluating diabetic macular edema were slit-lamp bio microscopy and stereoscopic photography, both of which are limited in detecting earlier retinal changes. Optical coherence tomography (OCT) is a new diagnostic imaging modality that provides high-resolution, cross-sectional images of the eye. It is proving to be an accurate tool for the early diagnosis, analysis and monitoring of retinopathy. It allows not only the qualitative diagnosis of diabetic macular edema, but also the quantitative assessment of edema.

**Objective**: To verify different morphological types of diabetic macular edema that needs different treatment strategies.

**Patients and methods:** A descriptive observational study was done in the OCT unit of Immam Hussain eye center in Kerbala city from December 2010 to May 2013. OCT done for 420 eyes of 237 patient. Cases with low image quality and cases with other eye disease were excluded.

**Results:** Of 420 eyes,211 eyes (50.4%) have OCT morphological appearance of diffuse spongiform DME,115 eyes (27.5%) mixed spongiform and cystoid edema, 56 eyes (13.3%) have cystoid changes, and 38 eyes ( 9% ) showed edema with traction at vitreoretinal interface.

**Conclusion:** Optical Coherence Tomography based classification of diabetic macular edema is more accurate in identifying the morphological types that need specific regimes of treatment and in the follow up the response to treatment.

**Keywords:** diabetic macular edema, Optical coherence tomography, morphology.

## Introduction

Diabetic macular edema (DME) can cause structural retinal changes severe enough to make it the most common cause of visual loss in patients with diabetes. Although the pathogenesis of DME is still not fully understood, it is mainly caused by the breakdown of the inner blood–retinal barrier[1] . Diabetic macular edema can develop at all stages of diabetic retinopathy (DR), but it appears to occur more frequently as the severity of DR increases. Risk factors that contribute to the progression of DME include increasing levels of hyperglycaemia, diabetes duration, severity of DR at baseline, diastolic blood pressure, hyperlipidemia and the presence of gross proteinuria[2].

Diabetic macular edema is defined by retinal thickening involving or threatening the centre of the macula [3,4] The clinical detection and evaluation methods currently used have until recently, been limited to slit-lamp biomicroscopy and stereoscopic photography . Routine slit-lamp biomicroscopy can provide information that is useful in the clinical diagnosis of DME. However, early detection of macular thickening is hard to estimate using this technique, and both slit-lamp

biomicroscopy and stereoscopic photography are subjective and insensitive to small changes in retinal thickness [5]. Measurement of the integrity of the blood–retinal barrier is a valid clinical entity that potentially allows for the detection of early stages of DR. Fluorescein angiography is useful for evaluating the severity of the dysfunction in the blood–retinal barrier; however, it does not reliably quantify the degree of fluid accumulation in the retina [6].

**Optical coherence tomography**

Optical coherence tomography was first commercially available in 1995; there has been tremendous progress in the development of this technology, as there has been in the understanding of the morphological changes associated with many macular diseases, including DME. Optical coherence tomography is a diagnostic tool for high-resolution imaging of ocular tissues. It produces cross-sectional images of optical reflectivity in the retina in a way that is analogous to the ultrasound B-scan [5,7]. It can achieve 2- or 3-dimensional cross-sectional imaging of tissue by measuring the echo delay and intensity of back-reflected infrared light from internal tissue structures, rather than acoustic waves from internal tissue structures . Optical coherence tomography is based on the principle of low-coherence interferometry, which measures the time of flight delay of light reflected from ocular structures . Low-coherence light is produced by a continuous-wave, super luminescent diode source, which is coupled into a fiber optic Michelson interferometer[8] . The proportion of the incident light that is directly backscattered by a tissue structure defines the reflectivity of that structure [9].

The OCT signal from a particular tissue layer is the combination of its reflectivity and the absorption and scattering properties of the overlying layers.

## Patients and methods

**Settings and samples:** Descriptive observational study for cases selected from OCT unit database in Immam Hussain medical center in kerbala from 27 of December 2010 to 30 May 2013.

**Participant:** Outpatients of Immam Hussain medical center mainly from kerbala city and the surrounding cities. Examination done with TOPCON 2000 OCT system , using macula 3D mode with 6mm area of examination at macula with macular preview images. We follow movie scan in the OCT to document foveal changes and to verify extrafoveal peripheral edema. . The TOPCON OCT system has additional property of taking fundus colored photo for each eye which demonstrate feature of diabetic retinopathy and its stage. All patients are adults from 21 to 85 years.145 of the patients were males, and 92 were females.209 of the patients from Kerbala city,the remaining 28 patients from Baghdad, Babylon, Najaf, Wast, Muthana, Missan and Basra.

**Inclusion criteria:** type 1 or type 2 diabetes mellitus with clinical evidence of diabetic retinopathy,

**Exclusion criteria:** disease**s** that cause poor image quality less than 50 (corneal opacity, mild and moderate cataract, intravitreal hemorrhage).Cases with other eye diseases (retinal venous occlusion, intraocular inflammation, age related macular degeneration and central serous chorioretinopathy) were excluded.Cases with previous macular laser were excluded as old laser may increase cystoid changes and make traction worse.

The OCT images are classified to 4 main categories according to their morphological appearance:

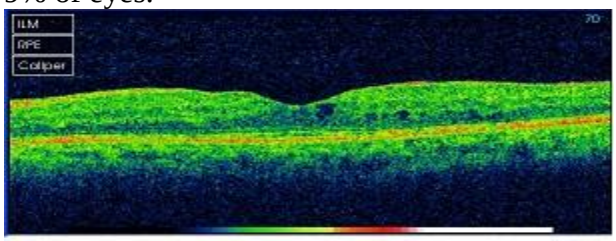
**Category 1**: diffuse spongiform edema in which there is homogenous thickening of the macula with no cystoid changes, cases of focal and multifocal edema were included in this group.

**Category 2**: mixed spongiform and cystoid edema which involve mainly diffuse edema with multiple cystoid spaces at the fovea and parafoveal area.

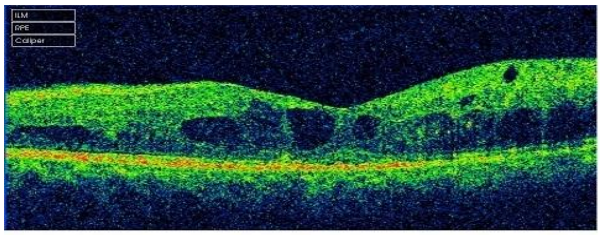
**Category 3**: cystoid edema which includes cystoid changes at the fovea and parafoveal area.
**Category 4:** tractional edema with abnormal vitreomacular interface.
The data were analyzed by excel sheet and SPSS programs.

## Results

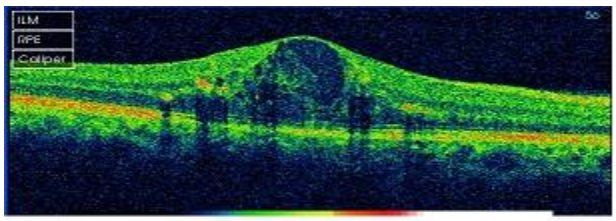
All the 420 eyes from 237 included in this study have clinically significant macular edema (CSME) which is morphologically classified to 4 categories.
About half of the eyes (50.4%) have diffuse edema. In the mixed category (27.5%) the main feature is spongiform with multiple cystoid spaces which occur mainly with hard exudates at the macula.
Cystoid edema present in only 13.3% of eyes, while tractional edema forms about 9% of eyes.



Figure(1):Diffuse spogiform edema



Figure(2):mixed spongiform and cystoid edema



Figure(3) :Cystoid edema

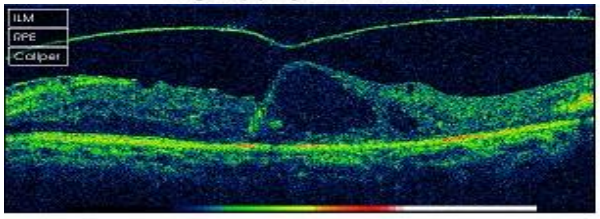


figure (4): tractional edema

Table 1. Relations between gender of the patients in the study

| Category No. | Total male eyes | Total female eyes |
|---|---|---|
| Category 1 | 104 | 107 |
| Category 2 | 61 | 54 |
| Category 3 | 36 | 20 |
| Category 4 | 10 | 21 |

P- value for gender of the patient equal to 0.182 which is not significant.

Table 2. Relations between sides of the eye of the patients in the study

| Category No. | RE | LE |
|---|---|---|
| Category 1 | 110 | 101 |
| Category 2 | 56 | 59 |
| Category 3 | 26 | 30 |
| Category 4 | 17 | 21 |

P- value for the side of the eye of the patient is not significant.

Table 3. Summary of the patients age in the study

| Age group | No. of patients | Percentage of patient |
|---|---|---|
| Less than 40 years | 13 | 5.5% |
| 40-49 | 27 | 11.4% |
| 50-59 | 117 | 49.4% |
| More than 60 years | 80 | 33.8% |

Mean age of the patients is 55.1 years.
Different treatment strategies can be planed accurately with or without macular laser therapy to achieve better results and rapid response.

## Discussion

Diabetic macular edema is one of the most significant causes of new blindness and severe visual impairment in patients with diabetes, which can result in reduced quality of life[10] . Early detection of retinal abnormalities is vital in preventing DME and subsequent loss of vision. Assessment of retinal thickness as well as morphological type of the edema is important for treatment and follow-up [11].

Although slit lamp biomicroscopy is highly sensitive for qualitative detection of CSME and FFA for detection of fluid leakage, various studies have ascertained that qualitative assessment and quantitative measurement of retinal thickening may correlate better with retinal dysfunction in patients with CSME[5] .

The sensitivity of OCT to detect DME is very high (98.6%), comparing to slit-lamp biomicroscopy OCT can detect macular thickening while the clinical examination still normal. OCT can detect subclinical DME which have thickness between 200um-300um while slit-lamp biomicroscopy detect only 14% from these cases [6] .

OCT enables the clinician to study their effects and show accurate subclinical retinal changes that may not be even detectable in FFA. It can show extrafoveal edema, and vitreoretinal interface relationship. It is approved that retinal thickness should increase between 1.3-1.5 of its size in order to be seen by slit lamp biomicroscopy [6] .

With the advent of newer medical therapies, intravitreal triamcinolone, posterior subtenons injection of triamcinolone, intravitreal anti-vascular endothelial growth factor therapy and vitrectomy for CSME, the role of macular laser in the management of CSME is better reserved for selected groups of patients.

In this study, we found that about 50.4 % of eyes have diffuse spongiform edema, 27.5 % have mixed spongiform and cystoid edema, 13.3 % have cystoid changes, and 9% of eyes showed tractional edema.

In Kerala university study; all patient (100%) have macular thickening and spongy edema, in this category, all eyes showed diffuse thickening of macula with small cystic spaces involve features of category 1 and category 2 in our study.38% have cystoids edema while 10% of the patients have traction at vitreomacular interface[5].

In Tunisian military department of ophthalmologist study, the OCT morphological features classified to 5 main types:

Type 1: focal macular thickening (30.3%)

Type 2: diffuse thickening without cysts (20.9%)

These 2 types have the same features of category 1 in our study

Type 3: diffuse cystoids macular edema (35.7%)

Type 4: tractional macular edema (13.1%) [6].

This classification is important, because macular laser can benefit mainly focal and multifocal extrafoveal edema, and of little benefit on cystoid edema and it may worsen tractional edema in addition to its known retinal complications[12,13] .

Diffuse spongiform and mixed edema can benefit from peri-ocular or intravitreal triamcinolone and intravitreal anti-vascular endothelial growth factor inhibitors[14] .

Sever mixed edema needs repeated intravitreal injections followed by macular grid laser after decrease of macular thickness to less than 300 um[15] .

Cystoid edema has better response to peri-ocular or intravitreal injections because it improves visual acuity and reduces central macular thickness more than macular laser treatment[16] .

Vitrectomy is the main treatment for tractional edema it may made worse by macular laser treatment[17,18] .

## Conclusion

Optical Coherence Tomography based classification of diabetic macular edema is more accurate in identifying the morphological type that needs specific regime of treatment and in the follow up the response to treatment.

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