Role of Optical Coherent Tomography in Evaluation of Diabetic Macular Edema

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Abstract

Purpose: To study the different optical coherence tomographic (OCT) patterns of diabetic macular edema, seen in Pakistani diabetic population so that each case can be treated accordingly.

Study Design: Descriptive, Observational study.

Settings: Ophthalmology departments of Allied Hospital, Punjab Medical College Faisalabad and Mayo Hospital, King Edward Medical University Lahore from April 2011 to October 2011.

Materials And Methods: One hundred and eighty (180) eyes of ninety five (95) patients were studied. All patients had diabetic macular edema and decreased visual acuity in one or both eyes. Fifty five (57.99%) were male and forty (42.11%) were female patients from 31 to 85 years of age with an average of 52.70 years. An OCT was done of each eye to see the structural changes of macula with RTVue 100-2 machine having axial resolution of five microns.

Results: Six different optical coherence tomographic patterns were seen. Diffuse retinal thickening was seen in all 180 (100%) eyes, cystoid macular edema in 109 (60.55%), sub retinal fluid in 40 (22.22%), epiretinal membrane in 18 (10%), vitreomacular traction in 10 (5.55%) and taut posterior hyaloid membrane in 4 (2.22%) eyes.

Conclusion: OCT is an important tool for evaluation of diabetic macular edema. It provides extremely useful information about the cause of macular edema. So the appropriate intervention, whether medical or surgical, can be done.

INTRODUCTION

Diabetes mellitus (DM) is a condition in which blood glucose level remains persistently high. It is the leading cause of blindness all over the world including the developed countries. Prevalence of DM is high in Pakistan. According to one report it is 7.6 to 11%[1]. Another study reported prevalence as high as 13.14% in Pakistani urban population[2]. Diabetes mellitus can cause many ocular problems. Diabetic macular edema (DME) is the main cause of visual impairment in diabetic patients[3]. The pathogenesis of DME appears to be multifactorial[4]. DME results from retinal microvascular changes. Thickening of basement membrane and reduction in the number of pericytes are believed to lead to increased permeability and incompetence of the retinal vasculature. This compromise of the blood retinal barrier leads to the leakage of plasma constituents into the surrounding retina with subsequent retinal edema[5].

Different modalities can be used for evaluation of DME like Fundus fluorescein angiography (FFA), Fundus photography and slit-lamp biomicroscopy with fundus viewing lenses. Optical coherence tomography is a new addition to this list. Many international studies have reported its importance in diagnosis and management of DME[6–9].

Optical coherence tomography (OCT) is a non-invasive technique used to take the optical sections of macula for evaluation of DME cases. So we can get very accurate information about anatomical derangements of macular area just like histopathology report but without taking any tissue from the retina. OCT has emerged as a promising new technique for high resolution, cross sectional imaging[10,11].

OCT is similar to ultrasound imaging with the exception that it uses light instead of sound. High resolution, cross sectional images are obtained by measuring the echo time delay of reflected infrared light using a technique known as low coherence interferometry[12]. Current ophthalmic OCT systems have 10 – 15 micron axial resolution and provide more detailed structural information than any other non-invasive ophthalmic imaging technique[13]. OCT performs cross sectional imaging of internal tissue microstructure by measuring the echo time delay of backscattered infrared light using a Michelson interferometer and a low coherence light source[14]. One arm of the interferometer directs the light onto the sample and a second reference arm has a retro-reflecting mirror that is precisely, mechanically translated. Interference between the light from the sample and reference path occurs only when the optical distance traveled by the light in both paths matches within its coherence length. The interferometric output is detected and demodulated to measure the echo time delay and magnitude of the backscattered light. By acquiring sequential transverse – axial measurements, the resulting data set is a two dimensional array representing the optical backscattering in a cross sectional plane of the tissue. This can be digitally processed and displayed as a gray- scale or false color image[15].

In an important review article Massin P and his colleagues described that OCT is a new diagnostic imaging modality that provides high resolution, cross-sectional images of macula. They concluded that OCT is an accurate tool for the early diagnosis, analysis and monitoring of DME cases. They further added that it allows not only the qualitative diagnosis of DME but also the quantitative assessment of edema. So at present and in future it looks to be the most important diagnostic and prognostic tool in management of DME[16].This non-invasive technique can provide reasonable information about the integrity of blood retinal barrier[17].

Study Design:

This was an observational study carried out simultaneously in Ophthalmology Departments of Mayo Hospital, King Edward Medical University Lahore and Allied Hospital, Punjab Medical College Faisalabad between April 2011 and October 2011.

Materials and Methods

Total one hundred and eighty (180) eyes of ninety five (95) patients were included in this research project. All patients were known diabetics having decreased visual acuity in one or both eyes due to diabetic macular edema. The patients were selected by simple random technique. Total male patients were fifty five (55) and female patients were forty (40). The age of the patients was between 31 and 85 years with an average of 52.70 years.

A written consent was taken from every patient. The best corrected visual acuity of each eye was estimated with the help of Snellen's chart. The pupils were dilated with 1% tropicamide eye drops. Detailed fundus examination was done with the help of slit-lamp biomicroscope along with +78 D fundus viewing lens. The patients who had dense opacities in refracting media or had 6/6 visual acuity were excluded from the study.

An OCT was done of each eye to see morphologic type of DME of every case. Spectral domain RTVue type IV machine having resolving power of 5 microns was used in this study.

Results:

Six different tomographic patterns of DME were seen.

1) Diffuse retinal thickening
2) Cystoid macular edema
3) Subretinal fluid
4) Epiretinal membrane
5) Vitreomacular traction
6) Taut posterior hyaloid membrane.

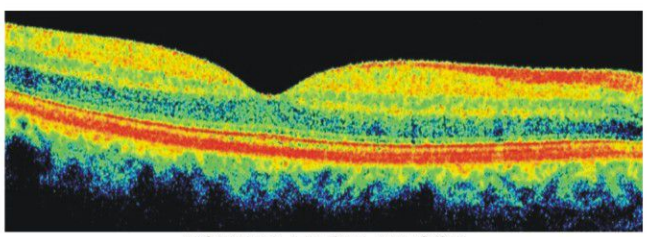
TABLE NO.1

Type of DME pattern on OCT	No. of cases (%)
Diffuse retinal thickening (DRT)	180 (100%)
Cystoid macular edema (CME)	109 (60.55%)
Subretinal fluid (SRF)	40 (22.22%)
Epiretinal membrane (ERM)	17 (9.44%)
Vitreomacular traction (VMT)	10 (5.56%)
Taut posterior hyaloid membrane (TPHM)	4 (2.22%)

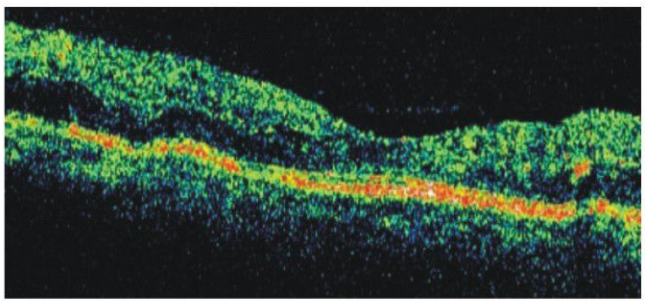
During this study it was noted that although six distinct optical coherence tomographic patterns of DME were seen but in many cases more than one pattern were noted. Diffuse retinal thickening was seen to some extent in every case. Retinal swelling was more pronounced in the outer rather than the inner retinal layers. Cystoid macular edema was located mainly in the outer retinal layers. Hard exudates were seen as highly reflective areas located in the outer retinal layers.

In those cases having sub retinal fluid some interesting features were noted. This type (SRF) was seen with other retinal abnormalities like diffuse retinal thickening or cystoid macular edema or hard exudates. In our study 40 cases had SRF. We did not see even a single case having only SRF with all other normal retinal layers. It shows that perhaps this finding appears in later stages of the disease or in more advanced cases. SRF cannot be diagnosed with clinical examination or even with fundus fluorescein angiography. This special type can only be diagnosed with the help of OCT. Furthermore lasers are not effective for these cases. Pharmacologic agents are needed for absorption of subretinal fluid. Then lasers can be applied, if indicated.

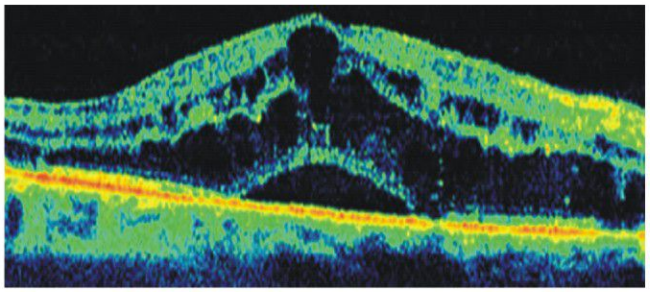
These patterns of diabetic macular edema appear on OCT as follows:



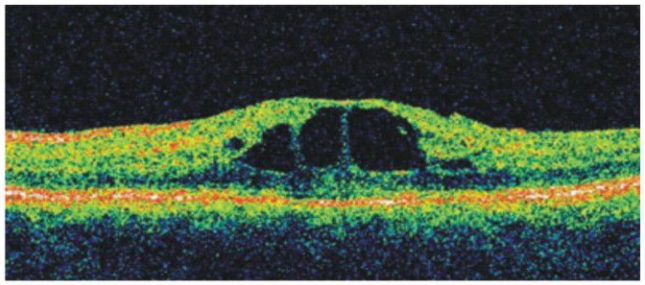
NORMAL MACULAR OCT



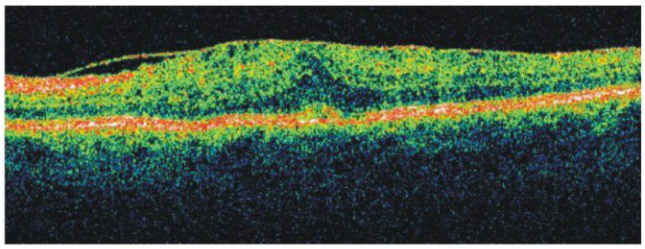
DIFFUSE RETINAL THICKENING



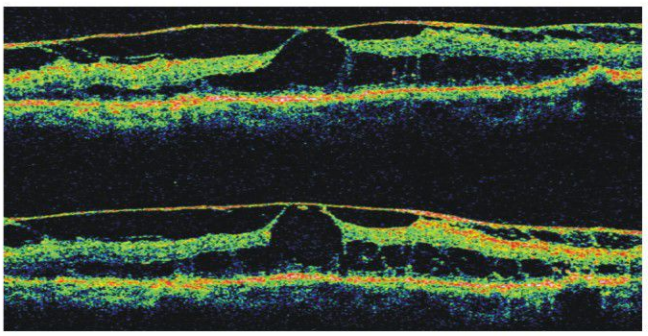
SUBRETINAL FLUID



CYSTOID MACULAR EDEMA



EPIRETINAL MEMBRANE



TAUT POSTERIOR HYALOID MEMBRANE

Keeping in view the different anatomical derangements and probable treatment plans of different cases we divided these six types into two main groups i.e. Group A (medical group) and Group B (surgical group). In group A the first three types were included which were DRT, CME, SRF while in group B the last three types ERM, VMT, TPHM.

Discussion:

Diabetic macular edema is the leading cause of visual impairment in patients with diabetes mellitus[3]. Many studies have shown the importance of OCT in evaluation of DME. Otani et al studied cross sectional images of DME cases. They reported that retinal swelling was more pronounced in the outer retinal layers rather than the inner retinal layers. Cystoid macular edema was located in the outer retinal layers[18]. These findings are almost similar as seen in our study. They also reported that some eyes had more than one pathologic change while our study too showed that many cases had more than one abnormality. Kim et al described various morphologic patterns of DME as demonstrated by OCT and correlated them with visual acuity[19].

Julia et al studied optical coherence tomographic findings seen at vitreomacular interface in those cases that had persistent DME and compared them with other diagnostic tools. It was reported that OCT is 1.94 times more sensitive in detecting vitreomacular interface abnormalities (VMIA) as compared with traditional techniques like Fundus Fluorescein Angiography (FFA), slit-lamp biomicroscopy and stereoscopic fundus photography. They found that out of 48 eyes 31 had definite or questionable VMIA and reached to this conclusion that OCT is highly useful tool for evaluation of vitreomacular interface abnormalities[20]. This finding is comparable to our results with difference of percentage because of difference of inclusion criteria.

Massin et al studied the role of OCT before and after vitrectomy of those cases that had DME and underwent vitrectomy. They reported that OCT allowed diagnosis of subtle vitreomacular traction and provided precise pre- and pos-toperative assessment of macular thickness[21]. They concluded that vitrectomy was beneficial in eyes with diffuse DME combined with vitreomacular traction. Our study suggests the similar implications.

Dehghan M and coworkers used OCT in patients who underwent pars plana vitrectomy (PPV) for refractory diffuse diabetic macular edema and found it highly helpful in comparison of pre and postoperative central macular thickness[22].

Ozdek S et al compared OCT, FFA and clinical findings in 195 eyes of 110 patients and reported the similar tomographic patterns as seen in our study[23]. They concluded that OCT can facilitate deciding on the treatment protocol (surgical or medical) and follow up of diabetic patients, which is especially important in the early stages of diabetic maculopathy when the structural changes are not yet evident with slit-lamp biomicroscopy or angiographically. They further reported that SRF is a special entity which could not be identified with slit-lamp biomicroscopy or FFA. It could only be detected by OCT.

Brar M and his colleagues did OCT and FFA of 107 eyes having macular edema due to different conditions like DME, ERM, uveitis, pseudophakic cystoid macular edema and retinal vein occlusion. They described the usefulness of OCT in these conditions with a special report that in3.73%of those cases which showed vascular leakage on FFA but had no abnormalities on OCT[24]. This happening may be seen in those very early cases where the vascular leakage was seen on FFA but because of healthy retinal pigment epithelium the fluid was being pumped out towards choriocapillaris. So on OCT no fluid collection was detected.

Implications:

All cases included in group A (Medical group) can be treated with laser treatment if the central macular thickness is slightly increased e.g. about 300 microns. If the central macular thickness is much more then it is better to decrease it by using pharmacological agents. Then the laser will be more effective even at lower energy levels. So OCT is extremely useful for proper diagnosis, management and even follow up of these cases.

In group B (Surgical group) there were 31 cases out of 180 eyes (17.22%) which means about one sixth of the total cases. All these cases needed surgical intervention like pars plana vitrectomy (PPV) with or without internal limiting membrane (ILM) or ERM peeling. OCT is mandatory for exact diagnosis and proper management of these cases. If any one does not use OCT in these cases he/she may cause more damage to macula by using repeated lasers or pharmacologic agents. So for proper evaluation and management of these cases OCT is very helpful.

Conclusion:

OCT is the most important diagnostic tool for proper evaluation of each case of diabetic macular edema. It provides extremely useful information about the cause of macular edema and the exact measurement of macular thickness. So an appropriate intervention, whether medical or surgical, can be done. Furthermore it can be a valuable prognostic tool for proper follow up of all cases of diabetic macular edema.

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