OCT Classification of Clinically Significant Macular Edema

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Introduction

Diabetic macular edema is the commonest cause of visual loss in patients with non proliferative diabetic retinopathy and a common cause of visual loss in PDR. According to Early Treatment Diabetic Retinopathy study, early detection and laser treatment of clinically significant macular edema decreases the risk of moderate visual loss by 50%. Though laser has been the standard of care till recently, many new treatment modalities are now available in the management of CSME. Even in the ETDRS, many patients treated with laser did not improve and actually had a visual drop, especially those patients with diffuse CSME. Why laser should be effective in certain subgroup and not in others could not be explained at that time.

Traditional methods of evaluating macular thickening including slit lamp biomicroscopy and fundus photography are relatively insensitive to small changes in retinal thickness and also unable to detect specific anatomic details especially at vitreomacular interface. Thus new techniques for quantitatively and qualitatively measuring retinal thickness have been explored. Recent imaging techniques can provide tomographic or cross sectional images of macula and can yield powerful diagnostic information, which is complimentary to FFA and fundus photo.

Optical Coherence Tomography (OCT) is a new medical diagnostic imaging technology which can perform micrometer resolution cross-sectional or tomographic imaging of macula. The operation of OCT is analogous to ultrasound B-mode imaging except that light is used rather than acoustic waves. OCT is established in the diagnosis of various macular disorders including CSME, macular hole, choroidal neovascular membrane etc.

Aim

The aim of the study was to identify and classify the OCT characteristics of clinically significant macular edema, its correlation to vision and to compare biomicroscopy with OCT.

Materials & Methods

This was a prospective study done between April 2006 and June 2006 in patients who attended the retina clinic of Chaithanya Eye Hospital, Trivandrum. 100 eyes (70 patients) of CSME were evaluated. The study group included both insulin dependent and non insulin dependent proliferative diabetic retinopathy and nonproliferative diabetic retinopathy patients between the age of 40 & 80 yrs. The study population had varied glycemic levels and HbA1c evaluation was not done. None of the patients in our study had undergone previous focal laser or pan-retinal photocoagulation. Such patients were excluded as these could interfere with anatomic changes at the macula and may alter the findings singularly due to disease manifestation. Few of the patients had associated other systemic diseases like hypertension, nephropathy & hypercholesterolemia and were on medications. The duration of diabetes was 7 yrs to 33 yrs. All patients underwent visual acuity estimation by Snellens Visual Acuity Chart, dilated Slit lamp -
90D examination, Fundus Fluorescein Angiography and Optical Coherence Tomography-4 by the same examiner. We considered macular edema to be clinically significant as per the definition by the Early Treatment Diabetic Retinopathy Study (ETDRS) protocol – that is, if there was retinal thickening or hard exudates associated with adjacent retinal thickening observed within 500 +/- 50 microns of the centre of foveal avascular zone or a zone or zones of retinal thickening 1 disc area or larger, any part of which was within 1 disc diameter of the center of the macula.

We classified patients into 4 groups based on slit lamp biomicroscopy findings as Gr.1a- non diffuse CSME, Gr.1b- diffuse CSME, Gr.2-CSME with ERM, Gr. 3- CSME with VMT/thickened posterior hyaloid, Gr.4- CSME with CME. A diagnosis of diffuse CSME was made if CSME involved the perifoveal region all around or atleast three quadrants. Fluorescein fundus angiography was done to classify the disease, to diagnose early PDR, CME and to rule out macular ischemia. Macular ischemia was defined on FFA as enlargement of foveal avascular zone compared to other eye with area of segmental or focal perifoveal capillary loss. Patients with macular ischemia were excluded from the study as these patients could alter the interpretation of results, which also aimed at correlating visual deficit with biomicroscopic and OCT features. OCT stratus-4 was done in all eyes, preferably a line scan programme was chosen and the image processed and analyzed. Based on OCT findings, we classified CSME into five groups, Gr.1- macular thickening with only spongy edema, Gr.2- macular thickening with ERM, Gr.3- macular thickening with VMT, Gr.4- macular thickening with CME and Gr.5- macular thickening with SRF.

**Results**

Of the total 70 patients, there were 17 patients in 40-49 yrs age group (24%), 29 in 50-59 yrs age group (42%), 21 in 60-69 age group (30%), 3 in 70-79 age group (4%) and none above 80 yrs. (Fig. 2) Males predominated in the study with 66%. The male: female ratio was 2:1. Of the 70 patients, 45 had NPDR (64%) and 25 had PDR (36%).

Biomicroscopically, 52% had diffuse CSME (Gr.Ia), 48% had focal CSME (Gr.Ib), 16% had CSME with CME (Gr.IV) and 2% had CSME associated with VMT (Gr.III) in the order of frequency. No patient had ERM and SRF clinically (Fig. 3).

OCT examination revealed (Fig. 4) macular thickening with spongy edema in all patients (100%), macular thickening (ME) associated with CME in 38%, ME associated with VMT in 10%, ME associated with SRF in 8% and ME associated with ERM in 2%. On OCT, eyes with spongy edema showed diffuse thickening of macula with small cystic spaces (Fig. 5). Eyes with CME showed (Fig. 6) large cystic spaces in the foveolar and parafoveal region. VMT (Fig. 7) was seen as
hyper-reflective band in the vitreous, which was adherent to the fovea, either centrally or paracentrally, causing traction and pulling up the macula. None of the patients had a defect suggestive of hole formation. SRF (Fig. 8) was seen as a subfoveal detachment on line scans. ERM (Fig. 9) was identified as a hyper-reflective thickening at the level of internal limiting membrane, causing distortion and flattening of the foveal surface.

Correlation of biomicroscopic and OCT finding with visual acuity revealed that 30% of eyes had a visual acuity of 6/9 or better, while 70% had vision worse than 6/9. Of those in biomicroscopy group with less vision, only 18% could be attributed to CME & VMT. No obvious clinical cause for defective vision was detected in the rest 52% eyes with visual loss. In OCT group, 58% could be attributed to CME, VMT & ERM. No obvious clinical cause for defective vision was detected in the rest 12% eyes with visual loss.

**Discussion**

- 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. OCT enables the
clinician to study their effects and show accurate subclinical
retinal changes that may not be even detectable in FFA.
Yang et al have suggested that the criteria of CSME
seems to be insufficient in identifying macular edema
and that OCT may be more sensitive than a clinical
examination in assessing diabetic macular edema and
is a better tool for documenting changes in macular
thickening. OCT-identified spongy retinal thickness and
or CME was seen in 58% of eyes without CSME in that
series. In our series, we found spongy thickening in all
the eyes and CME in 38 % with macular edema.
Schaudig et al also found similar observations and in
addition also showed a significant increase in macular
thickening in diabetic patients without retinopathy
compared to non-diabetic subjects. Browning et al had
demonstrated that the agreement between clinical
examination and OCT was good for moderate and
severe macular thickening (>300 microns) and poor
for mild macular thickening (200-300 microns). Most
of these studies have also found a positive correlation
between increasing macular thickening and visual loss.

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 laser in the management of CSME is better reserved
for selected groups of patients. OCT provides for a better
anatomical description of CSME for identification of
the medically and surgically treatable groups.

Hence our characterization of CSME patients based on
OCT into macular thickening with only spongy edema
(Gr.-1), macular thickening with ERM (Gr.-2), macular
thickening with VMT (Gr.-3), macular thickening with
CME (Gr.-4) and macular thickening with SRF (Gr.-5)
is more relevant. Structural changes in OCT in our series
correlate with other data from literature. Otani et al
found spongy retinal swelling in 88%, CME in 47% and
SRF in 15% of eyes with CSME. Kim et al found spongy
retinal swelling in 97%, CME in 55%, SRF in 7%, VMT
in 13% of eyes with CSME. Ozdek et al had reported
spongy retinal swelling in 66%, CME in 16% and SRF
in 10% of eyes with diabetic macular edema. In our
study, we found spongy retinal swelling in 100%, CME
in 38%, SRF in 8% and VMT in 10%.
On comparing OCT with biomicroscopy, 38% of the eyes had CME on OCT, compared to 16% detected on biomicroscopy. 8% of eyes had SRF with subfoveal detachment on OCT which was not identified on biomicroscopy. 10% of eyes had VMT on OCT compared to 2% on biomicroscopy. 2% of eyes had ERM identified by OCT compared to none on biomicroscopy. Browning DJ et al had also compared stereoscopic slit lamp examination and OCT in the study of CSME and concluded that stereoscopic slit lamp examination of the macula was less sensitive than OCT for detection of diabetic macular edema. Strom et al had found an agreement of 89% on the exact location and 84% agreement on the exact area of CSME when he compared biomicroscopy with OCT and found the latter to be more superior.

In our study, 38% of the eyes had CME on OCT, compared to 16% detected on biomicroscopy. Ozdek et al also found that 40% of CME detected on OCT were not detected by biomicroscopy and 63% were not detected even on fluorescein angiography. OCT is thus a better diagnostic tool to diagnose CME in patients with diabetic retinopathy than biomicroscopy or FFA. Kim et al also had reported that the presence of CME in patients with CSME was significantly associated with worse vision. In our study, 8% of the eyes had SRF with subfoveal detachment, which could not be detected on biomicroscopy or FFA. Most series have found SRF in 8-12% of eyes with CSME. Ozdemir et al had reported that 31% of diabetic CMEs had subretinal fluid. Previously it was believed that SRF was seen in eyes with taut thickened posterior hyaloid, but many series had found evidence to the contrary. Thomas et al found SRF to be associated with taut hyaloid in only 33% of eyes and the rest without posterior hyaloid separation. 10% of eyes in our series had VMT on OCT compared to 2% on biomicroscopy. VMT has been reported by various authors between 10-60% of eyes with CSME. One study which specifically looked at vitreoretinal interface changes in CSME found no PVD in 40% eyes, 53% perifoveal PVD, 2% with incomplete PVD attached to disc and 6% with complete PVD. These results show that though PVD is not the main factor involved in the pathogenesis of diabetic macular edema, perifoveal PVD may have a role in the development of this complication. This may have a bearing on planning management strategies especially with regards to indications for vitrectomy for CSME.

ERM was also detected in 2% of eyes on OCT compared to none on biomicroscopy in our study. Subtle ERM may therefore be missed on routine clinical examination and may need OCT to diagnose it. Wilkins et al found two types of ERM in patients with CSME, globally adherent ERM in 67% and focally adherent ERM in 33%. This may be another indication for vitrectomy in CSME.

As macular ischemia can be a cause of visual defects in patients with CSME, the present study excluded this subgroup of patients during the analysis. Correlation of biomicroscopic finding with visual acuity revealed that 30% of eyes had a visual acuity of 6/9 or better, while 70% had vision worse than 6/9. Of those with less vision, only 18% could be attributed to CME & VMT. No obvious clinical cause for defective vision was detected in the rest 52% eyes with visual loss. OCT evaluation of those eyes with visual acuity of less than 6/9 revealed CME in 38% of these eyes, VMT in 10% eyes, SRF in 8% eyes and ERM in 2% of eyes, thereby offering a better understanding of the cause of visual loss in these patients. Alkuraya et al had reported that there was a positive correlation between the type of OCT finding and visual acuity. Patients with CME and VMT had worse vision. Most of the other series had reported that the visual acuity correlated better with macular thickness, i.e more the central foveal thickness, worse the vision. It is also known that the central foveal thickness increases with the different types of OCT presentations, being least for spongy thickening, moderate for CME/SRF and highest for VMT and thus visual loss mirrors these changes.

Thus these structural changes correlate better with the visual defects the patients with CSME have in the absence of macular ischemia in our series. Detection of these findings has a bearing in planning treatment strategies. Eyes with CME and SRF will probably respond poorly to conventional laser and require additional medical management in the form of IVTA or PST. Eyes with VMT and ERM probably are poor candidates for laser and are better managed by primary vitrectomy. Identification of these findings on OCT will optimize treatment in CSME, which will have a bearing on the final visual acuity maintained or achieved.
Conclusion

We found that OCT is a useful technique for quantitative measurement and helps in better anatomical characterization of CSME and thereby more relevant while planning management strategies, followup, explaining prognosis and predicting visual outcome. OCT characterization of CSMEs identified groups that correlate better with visual acuity than slit lamp biomicroscopy. Patients with CSME and only spongy macular thickening on OCT probably respond better to conventional therapy. Patients with CME and SRF respond best to IVTA and PST injections with or without focal laser and patients with ERM and VMT respond best with vitrectomy.

References

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