Retinal thickness in diabetic macular edema: A study using optical coherence tomography (OCT)

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Abstract

Introduction: Macular edema is the most frequent cause of visual impairment in patients with Nonproliferative Diabetic Retinopathy (NPDR). Clinically they are differentiated as focal and diffuse. Optical coherence tomography (OCT) can measure the retinal thickness and assess the response of surgery. This study was done to evaluate the efficacy of OCT as an investigative tool in diabetic macular edema.

Materials and Methods: A prospective study was done among 30 consecutive eyes with Clinically Significant Macular Edema (CSME) over 8 months in our institution and divided into two groups with 15 each as focal and diffuse on the basis of fundus bio-microscopy and fluorescein angiography. Baseline measurements were done by OCT. Patients were followed up after surgery at 4 weeks and 12 weeks with repeat measurements. Data entered in excel sheet and analyzed using SPSS software. Data presented as tables and graphs with Spearman’s correlation and Paired t test.

Results: Among 15 eyes with focal macular edema mean age of patients was 59.80 ± 5.13 years whereas among diffuse macular edema, it was 67.80 ± 3.76 years. There was negative correlation between BCVAb and FOVb among both the groups which was significant. (p=0.033, p<0.01). When Best corrected visual acuity, central foveal thickness, perifoveal thickness, maximum retinal thickness and total macular volume were compared at baseline, 4 weeks and 12 weeks after surgery, it was found that OCT was effective investigative tool in case of diabetic macular edema to assess the response of surgery.

Conclusion: Optical coherence tomography is a useful modality of investigation in patients with diabetic macular edema. Thus OCT can be used for quantitative assessment in response to surgery.

Keywords: Diabetes, Investigative tool, Macular edema, Retinal thickness.
to central or branch vein occlusion or any other diseases of the eye that can have an effect on vision like ARMD etc. Informed consent was obtained before inclusion and the study was performed in accordance with common ethical standards. A standard eye examination including best-corrected visual acuity (ETDRS chart), slit-lamp biomicroscopy (90-diopter [D] lens), clinical fundus photography, fluorescein angiography and retinal thickness with OCT was done. The blood level of glycosylated hemoglobin (HBA1c), FBS, PPBS was determined to assess the quality of blood sugar control. Patients were followed up at 4 weeks and 12 weeks after surgery. 

**Optical Coherence Tomography:** Patients underwent axial length measurements and estimation of refractive error as prerequisites to the documentation of OCT. OCT evaluation was carried in Humphrey Zeiss Stratus 3.0. Patients were briefed about the procedure and consent was taken. Patient details were fed to the computer. The scan image was optimized. Fast macular thickness type of scan mode was selected with 6 radial scans of 6 mm at 30° interscan distances taken in each eye which was to be evaluated. Retinal thickness/volume tabular output analysis protocol was used to analyze the retinal thickness.

Retinal scan images were acquired from the retinal map analysis protocol.

**Statistics Analysis**

The data were entered in a Microsoft excel spreadsheet and analyzed using SPSS software. The demographical data was analyzed with descriptive and the correlations by Spearman’s correlation. The main effects of the repeated measures were analyzed on a general linear model, comparing with confidence interval adjustment being done by Bonferroni method. Means were compared by using Paired t test.

**Results**

Among 15 eyes with focal macular edema mean age of patients was 59.80 ± 5.13 years ranging from 53–70 yrs. Whereas among diffuse macular edema, it was 67.80 ± 3.76 years, ranging from 53–68 years. (Table 1)

<table>
<thead>
<tr>
<th>Socio-demographic variable</th>
<th>Focal</th>
<th>Diffuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean ± SD)</td>
<td>59.80 ± 5.13 yrs</td>
<td>67.80 ± 3.76 yrs</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>12 (80%)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3 (20%)</td>
</tr>
</tbody>
</table>

**Fig. 1:** Correlation between BCVAb and FOVb of diffuse macular edema patients

**Table 1:** Socio-demographic determinants of study participants

**Spearman’s Correlation co-efficient = 0.826, p < 0.01**
In both the groups there was negative correlation between BCVA\textsubscript{b} and FOV\textsubscript{b} which was significant. (Fig. 1 and 2).

The retinal thickness in each area was noted and the area in which there was maximum retinal thickness was marked for each individual patient. Among diffuse group temporal inner macula was the most commonly involved area where the retina was maximally thickened with 27% of patients having maximum thickness in this area followed by fovea where 20% of patients had maximum thickness of retina in this area. Where-as among focal group superior inner macula was the most commonly involved area where the retina was maximally thickened with 34% of patients having maximum thickness in this area followed by nasal inner macula where 20% of patients had maximum thickness of retina in this area.

Table 2: OCT measurements among patients with focal macular edema

<table>
<thead>
<tr>
<th>Focal Macular Edema</th>
<th>BCVA (mean)</th>
<th>Central foveal thickness (mean microns)</th>
<th>Peri-foveal thickness (mean microns)</th>
<th>Maximum retinal thickness (mean microns)</th>
<th>Total macular volume(mean cumm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.55</td>
<td>275</td>
<td>282</td>
<td>342</td>
<td>7.83</td>
</tr>
<tr>
<td>4 weeks</td>
<td>0.58</td>
<td>298</td>
<td>291</td>
<td>338</td>
<td>7.83</td>
</tr>
<tr>
<td>12 weeks</td>
<td>0.69</td>
<td>296</td>
<td>284</td>
<td>322</td>
<td>7.63</td>
</tr>
<tr>
<td>p value (baseline and 4 weeks, baseline and 12 weeks)</td>
<td>(0.52, 0.74)</td>
<td>(0.28, 0.96)</td>
<td>(0.349, 1.0)</td>
<td>(1.0, 0.677)</td>
<td>(1.0, 1.0)</td>
</tr>
</tbody>
</table>

Table 3: OCT measurements among patients with diffuse macular edema

<table>
<thead>
<tr>
<th>Diffuse Macular Edema</th>
<th>BCVA (mean)</th>
<th>Central foveal thickness (mean microns)</th>
<th>Peri-foveal thickness (mean microns)</th>
<th>Maximum retinal thickness (mean microns)</th>
<th>Total macular volume(mean cumm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.46</td>
<td>376</td>
<td>354</td>
<td>450</td>
<td>9.56</td>
</tr>
<tr>
<td>4 weeks</td>
<td>0.42</td>
<td>368</td>
<td>331</td>
<td>392</td>
<td>8.86</td>
</tr>
<tr>
<td>12 weeks</td>
<td>0.49</td>
<td>307</td>
<td>308</td>
<td>351</td>
<td>8.49</td>
</tr>
<tr>
<td>p value (baseline and 4 weeks, baseline and 12 weeks)</td>
<td>(1.0, 1.0)</td>
<td>(1.0, 0.06)</td>
<td>(1.0, 0.06)</td>
<td>(0.135, 0.018)</td>
<td>(0.281, 0.89)</td>
</tr>
</tbody>
</table>

When Best corrected visual acuity, central foveal thickness, perifoveal thickness, maximum retinal thickness and total macular volume were compared at baseline, 4 weeks and 12 weeks after surgery, it was found that OCT was effective investigative tool in case of diabetic macular edema to assess the response of surgery. (Table 2 and 3)

Discussion

In our study, the patients were subjected to retinal thickness evaluation at prior to laser photocoagulation and then at 1 and 3 months after the treatment. The follow up period of the study conducted by Rivellese M et al\textsuperscript{5} was 12-18 weeks, Shilelattanzio et al\textsuperscript{6} had a follow up period of more than 3 months. The prospective study by Masahiko
Shimura et al.\(^7\) had a follow up of 6 months, while Laursen M L et al.\(^8\) had retinal thickness evaluated at 3 and 6 months.

Patients with diabetic macular edema have shown correlation coefficients between visual acuity and central foveal thickness (p<0.001). Our study also confirmed the correlation (p=0.001). However, Laursen M L et al.\(^8\) could not find such a correlation (p=0.37). Some patients had stabilized or even improved visual acuity in spite of an increase in central foveal thickness when individual patients were analyzed in our study and as well in study by Laursen M L et al.\(^8\). This incites need for further work on the understanding of the concept in relation to each layer of the retina at the fovea. Such an effort is possible as optical coherence tomography provides high resolution cross sectional images of the retina.

All previous studies had measured retinal thickness in the central fovea. Rivellese M et al.\(^5\) found that the average central foveal thickness for all prior to laser photocoagulation was \(368 \, \mu\) and post treatment central foveal thickness was \(276 \, \mu\). The Percentage decrease in the central foveal thickness would therefore be 25% Lattazio R et al\(^6\) also noted that the central foveal thickness before and after treatment was \(468.2+83.17 \, \mu\) and \(372.1 + 120.63 \, \mu\). This would account for a decrease of 20.5%.

In the study by Masahiko Shimura et al.\(^7\) there was a decrease in the mean central foveal thickness with thickness before laser therapy being \(534.7 \pm 120 \, \mu\) and that after 6 Months of laser therapy found to be \(286.9 \pm 98.6 \, \mu\), which corresponded to a decrease of 45.4% \(\pm \) 17.1% Laursen M L et al\(^1\) the central foveal thickness at baseline was \(293 \pm 43 \, \mu\) and following laser therapy the central foveal thickness was \(318 \pm 74 \, \mu\) and \(341 \pm 81 \, \mu\) at 3 and 6 months respectively.

**Conclusion**

Optical coherence tomography is a useful modality of investigation in patients with diabetic macular edema. Thus OCT can be used for quantitative assessment in response to surgery.

**Conflict of Interest:** None.

**References**


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