Changes in choroidal thickness in relation to the severity of retinopathy and macular edema in type II diabetic patients

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Abstract

Purpose: To assess changes in choroidal thickness in diabetic patients with diabetic retinopathy (DR) and diabetic macular edema (DME) using enhanced-depth imaging optical coherence tomography (EDI-OCT).

Design: A retrospective, observational, cross-sectional study.

Participants: Eyes (n=225) from 145 diabetic patients (70 men, 75 women) who underwent fluorescein angiography and EDI-OCT, both within a span of two weeks, between March and December 2011.

Methods: Subjects with a history of ocular treatment except laser photocoagulation (PPR), were excluded. Eyes (215) were divided into groups according to the grade of DR: no DR, mild/moderate nonproliferative DR (NPDR), severe NPDR, proliferative DR (PDR), and PPR with PPR (treated) eyes. With DR and no history of PPR (15%) were divided into those without DME and with DME, grouped according to DME type (DME, PDR, and DME with PDR). Subfoveal choroidal thickness (SFChT) and parafoveal choroidal thickness (PFChT) at 1500 μm from the fovea in the nasal, temporal, superior, and inferior quadrants was measured using EDI-OCT.

Results: Mean patient age was 62±12.4 years, and mean duration of DM was 15.1±7.2 years. Mean SFChT in groups with no DR (40 eyes), mild/moderate NPDR (47 eyes), severe NPDR (22 eyes), untreated PDR (38 eyes), and treated PDR (40 eyes) was 262±16.8 μm, 246±7.0 μm, 291±10.7 μm, 365±7.4 μm, and 239±8.1 μm, respectively. Mean SFChT was greater in eyes with untreated PDR than in those with no DR (p<0.05), mild/moderate NPDR (p=0.02), or severe NPDR (p=0.05). Mean SFChT decreased significantly in treated PDR eyes compared with untreated PDR (p<0.05). Eyes with DME (57 eyes) had a thicker subfoveal choroid than eyes without DME (88 eyes; p<0.05), and compared with other subfoveal choroidal thickness was thicker in DME type DME (215±6.6 μm; p<0.05).

Conclusions: Choroidal thickness increased significantly as the severity worsened from mild/moderate NPDR to PDR, and decreased in laser-treated eyes. The subfoveal choroid was thicker in eyes with DME than in those without, and was thickest in eyes with AMD type DME.

The role of choroid:
- Blood supply to the outer retina, including the retinal pigment epithelium (RPE) and photoreceptors associated with the pathophysiology of many retinal diseases
- Previous studies of choroid in patients with diabetes or diabetic retinopathy (DR)
- Histopathologic study: vascular abnormalities in the choroidal layer
- Indocyanine green angiography studies: hyperfluorescent spots: sign of intra-choroidal vascular abnormalities or dilation of the choroidal vessels
- Choroidal blood flow study: pulsatile ocular blood flow is increased in non-proliferative retinopathy (NPDR) and decreased in treated proliferative retinopathy (PDR)
- Enhanced depth imaging with spectral domain optical coherence tomography (EDI-OCT): novel way to measure the choroidal thickness (CT) in normal and pathologic states

A few recent studies reported changes in choroidal thickness (CT) in diabetic patients, the relationship between changes in CT and the severity of DR or the DME subtype has not been systematically investigated using EDI-OCT.

The present study was designed to investigate how CT changes according to DR severity, and whether the CT varies according to DME subtype.

Patients & Methods

Patient Eligibility:
- A retrospective review was performed on all diabetic patients who were examined at the Diabetes Center of Asian Medical Center, Seoul, Korea, between March and December 2011.
- All patients had a complete ophthalmic examination, including manifest refraction, best-corrected visual acuity assessment, slit-lamp biomicroscopy, and a detailed fundus examination.
- Among them, only patients who had undergone fundus photography/fluorescein angiography (FA) and spectral domain optical coherence tomography (SD-OCT, Spectralis, Heidelberg Engineering, Heidelberg, Germany), both within a span of two weeks, were selected for this study.

Selection criteria:
- Exclusion of errors of more than ±0.3 diopters
- Glaucoma unless treated
- Cataract
- History of choroidal neovascularization (CNV)
- History of macular surgery (cystectomy, macular laser treatment)
- History of any previous intravitreal injection
- Anterior or vitreous hemorrhage
- History of ocular trauma

Choroidal thickness measurement using EDI-OCT:
- Measured by an investigator masked to the DR grading and DME subtypes
- Subfoveal choroidal thickness
- Measured at the fovea manually
- Measured using EDI-OCT- Heidelberg Eye Explorer software
- From hyperreflective line of Bruch’s membrane
- To the hypo-reflective line of the sub-retinal interface
- Parafoveal choroidal thickness
- Measured at the nasal, temporal, superior, and inferior choroidal quadrants
- Manually measured distance of 1500 μm from the foveal center
- Normal control data
- From normal eyes of age-matched patients who underwent vitrectomy for idiopathic epiretinal membrane or macular hole
- Statistical Methods:
- All values are given as mean±standard error of the mean
- Statistical analysis was performed using SPSS for Windows version 16.0 (SPSS Inc, Chicago, IL).

Conclusion

This study demonstrates that CT is closely correlated with the stage of DR, and with the degree of DME.

The choroidal thickness layer with the progression of DR or the development of DME, may reflect the concurrent progression of diabetic choroidopathy.

EDI-OCT is a non-invasive technology that enables accurate assessment of choroidal vascular changes in diabetic patients.

References

8. Lee DH, Lee DS, Kim JH, et al. Comparison of the mean subfoveal choroidal thickness (SFT) in eyes with and without diabetic macular edema (DME). Eye with DME had increased SFT compared with eyes without DME (independent t-test: one way, p<0.05). (B) Scanning show changes in central subfoveal choroidal thickness of the retina in macular edema. (B: DME thickness (μm). The Pearson correlation coefficient was 0.588 between CT and SFChT (p=0.016).

Table 1. Baseline characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No DR</th>
<th>Mild NPDR</th>
<th>Severe NPDR</th>
<th>Untreated PDR</th>
<th>Treated PDR</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFChT (mean)</td>
<td>329.4±11.3</td>
<td>319.7±11.1</td>
<td>272.5±11.4</td>
<td>262.9±11.4</td>
<td>255.1±11.3</td>
<td>0.001</td>
</tr>
<tr>
<td>PFChT (mean)</td>
<td>349.5±12.4</td>
<td>339.5±12.4</td>
<td>309.7±12.4</td>
<td>299.4±12.4</td>
<td>292.4±12.4</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table 2. Mean subfoveal choroidal thickness (SFChT) and parafoveal choroidal thickness (PFChT) at each of the five locations in diabetic patients

<table>
<thead>
<tr>
<th>Location</th>
<th>No DR</th>
<th>Mild NPDR</th>
<th>Severe NPDR</th>
<th>Untreated PDR</th>
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<td>PFChT</td>
<td>349.5±12.4</td>
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<td>309.7±12.4</td>
<td>299.4±12.4</td>
<td>292.4±12.4</td>
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</table>

Figure 1. Fundus photograph, fluorescein angiography (FA), and enhanced-depth imaging of representative cases using OCT in diabetic retinopathy (DR). (A) FA: mild non-proliferative diabetic retinopathy (NPDR) showing early vascular leakage, hard exudates, and microaneurysms. (B) Enhanced depth imaging (EDI) of the same case as (A). (C) FA: proliferative diabetic retinopathy (PDR) showing new vessel formation. (D) EDI-OCT of the same case as (C). These figures indicate hypo-reflective line of the choroidal-ocular interface of EDI-OCT. Green marking indicates choroidal thickness measured with the caliper program of the Heidelberg Eye Explorer software of EDI-OCT.