Staging of idiopathic choroidal neovascularization by optical coherence tomography

Abstract  
**Purpose:** To assess the clinical course of idiopathic choroidal neovascularization (ICNV) by optical coherence tomography (OCT).  
**Methods:** Thirty-two patients with a clinical diagnosis of ICNV were examined between December 1995 and October 1999. The ages of the patients ranged from 18 to 53 (mean 35.9) years, and the mean period of observation was 5.8 months. Color fundus photography, fluorescein angiography, Indocyanine green angiography, and OCT were performed. The stage of the ICNV was classified as active, intermediate, or cicatricial, based on past history, fundus findings, and fluorescein angiography (FAG). The characteristic OCT images at these three stages were determined.  
**Results:** OCT revealed that there were characteristic tomographic images of the choroidal neovascularization (CNV) at each stage. In the active stage, OCT revealed the CNV as a highly reflective, multi-layered area protruding into the subretinal space. In the intermediate stage, the reflectivity of the CNV became stronger and its margin in the subretinal space became smooth. With regression of the ICNV, the lesions consisted of two different areas: a most reflective area corresponding to the fibrotic changes of the CNV (imaged white in OCT images), and a reddish highly reflective area representing a compound protrusion of the CNV. In the cicatricial stage, the ICNV was observed as a moderately high reflective area covered by a dome-shaped highly reflective layer corresponding to the retinal pigment epithelium.  
**Conclusion:** These findings demonstrated clearly the changes in the OCT images during the development and regression of ICNV. OCT was useful for following the clinical course and understanding the mechanism of the CNV regression.

Introduction

Idiopathic choroidal neovascularization (ICNV) is a type of neovascular maculopathy that is seen in relatively young individuals [1, 13]. ICNV is characterized by small neovascular lesions under the sensory retina in the macular area, corresponding to type 2 lesion in Gass’ classification [5]. In some cases, there is spontaneous regression of the ICNV [9]. The mechanism of spontaneous regression has only been inferred from funduscopic and fluorescein angiographic (FAG) observations because only a small number of histological studies has been performed on eyes from patients with ICNV.

In this study, we investigated the course of ICNV and the changes during the regression process by optical coherence tomography (OCT).

Subjects and methods

Thirty-two eyes of 32 patients with ICNV were studied with OCT at the Department of Ophthalmology in Kansai Medical University between December 1995 and October 1999. Among the 32 pa-
tients, 25 underwent OCT measurement once, 6 underwent measurement twice, and 1 patient underwent measurement 3 times. In all, 40 OCT examinations were performed to analyze the features of ICN. The ICNs were then classified into three stages.

Ophthalmoscopy, slit-lamp examination, FAG (TRC, Topcon, 50AX, Japan), Indocyanine green (ICG) videoangiography and OCT (Humphrey, USA) were performed on all patients. The tomographic structure of the CNV and the retinal changes in the macula were documented by OCT. Vertical and horizontal scans (scan length 2.83–5.62 mm) were performed in all cases in order to encompass the center of the lesions and the surrounding normal tissues. OCT images are color-coded so that as the reflectivity increases, the color changes from black to blue, green, yellow, red, and white, i.e., from low to high reflectivity.

Ophthalmoscopy and slit-lamp examination with a fundus lens showed exudative changes such as serous retinal detachment and subretinal hemorrhage. FAG showed well-defined CNV in all patients at the initial visit. In general, when both subretinal hemorrhage and serous retinal detachment have disappeared completely, it is considered that the CNV activity has resolved. However, in this study, the activity of CNE was considered to have subsided when the serous retinal detachment had disappeared and/or when there was only a small amount of residual subretinal hemorrhage. Choroidal neovascular (CNV) lesions were classified into three stages based on past history, fundus findings, and FAG. Eyes that showed subretinal hemorrhages, retinal detachment, and CNV lesions with active leakage of fluorescein in the late phase were classified as being in the active stage. Eyes were placed in the intermediate stage if they had prolonged symptoms of visual impairment, residual exudative changes from the CNV, and early signs of cicatricial changes. Finally, eyes that showed complete regression of the CNV, disappearance of the exudative changes around the CNV, and CNV lesion with no leakage of fluorescein in the late phase were classified as being in the cicatricial stage.

We studied three points at each stage: the rate of CNV detection by OCT, the OCT features of the CNV, and the OCT features of the neurosensory retina.

**Results**

There were 12 men and 20 women aged 18–53 years, with a mean of 35.9±9.2 years. Characteristics of the 32 patients and their CNV are shown in Table 1. Thirteen patients had active CNV, 10 had intermediate CNV, and 9 had cicatricial CNV. The interval between first symptoms of visual impairment to initial OCT ranged from 4 days to 24 months, with a mean of 5.4±5.3 months. Forty OCT examinations were conducted on 32 patients. Among the six patients who had two OCT measurements, one patient showed active stages in both measurements, one patient changed from active to intermediate stage, one patient changed from active to cicatricial, and three patients changed from intermediate to cicatricial. The one patient who had three OCT examinations demonstrated a CNV that was in the active stage in two measurements and had become cicatricial by the time of the third measurement. Thus, overall, by OCT examinations, 15 eyes demonstrated the active stage of CNV, 11 eyes showed the intermediate stage, and 14 eyes were in the cicatricial stage.

**Detection rate of CNV by OCT**

In 36 (90.0%) of 40 eyes that had FAG and in 27 (93.1%) of 29 eyes which were examined by ICG, hyperfluorescence from the CNV could be clearly seen in each of the three stages. In all of these cases, the OCT image of the CNV area showed a thickening appearance, including the retinal pigment epithelium (RPE) layer, such as a multilayered or fusiform highly reflective area, or a dome-shaped, highly reflective elevation, which was continuous with the highly reflective layer corresponding to the RPE.

In addition, the CNVs in the other four eyes in which they had not been detected by FAG and the two eyes in which they had not been detected by ICG were detectable on OCT by virtue of abnormal reflection in the CNV area. In eyes that showed a multilayered highly reflective appearance on OCT, the reflection, mostly red in color, projected towards the subretinal space. Such reflection was also clearly delineated from the other surrounding subretinal tissues, except for fresh subretinal hemorrhage, which usually shows high reflection on OCT. However, in the seven cases which showed fusiform thickening of RPE, it was difficult to distinguish between RPE and CNV on the OCT image because of the obsccurity of the borders and the similarity in transparency.

ICG angiograms showed a continuously or intermittent hypofluorescent (dark) rim around neovascular membranes in the late phase in 22 (75.9%) of 29 eyes. While dome-shaped reflection of RPE was seen in 16 of the 22 eyes with a dark rim on ICG angiography, two of seven eyes were without a dark rim.

**OCT features of CNV**

**Active stage**

In the active stage, the CNV was observed by OCT as a disruption of the most reflective layer (imaged white) which corresponded to the RPE and choriocapillaris (Fig. 1). In the region of the disruption, there was a sub-

**Table 1** Characteristics of patients and stage of choroidal neovascularization (CNV) at initial visit

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Active (n=13)</th>
<th>Intermediate regressive (n=10)</th>
<th>Cicatricial (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>13</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>37.2±9.4</td>
<td>37.6±9.9</td>
<td>34.2±7.9</td>
</tr>
<tr>
<td>Gender (M:F)</td>
<td>3:10</td>
<td>4:6</td>
<td>5:4</td>
</tr>
<tr>
<td>Duration* (months)</td>
<td>2.9±3.2</td>
<td>5.0±4.1</td>
<td>9.9±6.8</td>
</tr>
</tbody>
</table>

* Time from presenting symptoms to initial visit