LABORATORY INVESTIGATION

How Spatial Orientation of Japanese Text Affects Fixation Points in Patients with Bilateral Macular Atrophy

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Abstract

Purpose: To ascertain the retinal area used by patients with bilateral macular atrophy when reading Japanese text of different character sizes written horizontally or vertically. In addition, to determine fixation points as part of the first of a series of studies designed ultimately to enhance the quality of life of these patients through the improvement of reading acuity.

Methods: Seventeen patients (34 eyes) with bilateral macular atrophy were tested to determine the retinal area employed for reading (R fixation point). Sentences were arranged either horizontally or vertically and projected onto the retina using a scanning laser ophthalmoscope. We also determined the fixation point using microperimetry (M fixation point). The positional relationships between these two fixation points and the scotoma were examined.

Results: The R and M fixation points were the same in 20 of the 34 eyes. Multiple R fixation points were found in 11 eyes. The R fixation point was frequently positioned above the lesion when reading horizontally (nine eyes), while it was often positioned in the area nasal to (eight eyes) or temporal to (six eyes) the lesion when reading vertically.

Conclusions: Fixation points changed frequently in these patients with bilateral macular atrophy depending on the spatial orientation of the text. These data should be used in the future to help patients learn how to use the preferred retinal locus to improve their reading skills and enhance their quality of life.

Key Words: bilateral macular atrophy, fixation point, microperimetry, reading acuity, scanning laser ophthalmoscope

Introduction

Von Noorden and Mackensen¹ reported in 1962 that patients with central scotoma develop, over the course of time and with practice, a new fixation area outside of the fovea, and they named this fixation point the preferred retinal locus (PRL). Cummings et al.² reported the same findings in 1985, and they called this same fixation point the pseudo-fovea. Both terms are in use at present; however, we shall refer to the new fixation point as the PRL.

The PRL appears to differ depending on the type and size of the target object in an eye that has been damaged within the fovea. However, despite considerable research done using the Roman alphabet,³–¹⁰ almost no studies have been conducted using other writing systems, including Japanese. Since Japanese can be written in both horizontal and vertical directions, clearly additional research must examine the coping strategies adopted by Japanese patients with bilateral macular atrophy, particularly in regard to the spatial orientation of the text. We thus decided to take a first step to improve the reading performance of patients with bilateral macular atrophy in order to improve the quality of life (QOL) of such patients. This first step took

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the form of identifying a reading fixation point using Japanese text to help determine the ideal PRL when reading Japanese.

We have previously reported on our initial efforts, which included the creation of new scanning laser ophthalmoscope (SLO) software designed to examine the fixation point during reading by patients with bilateral macular atrophy. This software allowed us to change the character size and measure the fixation point when the patient was reading horizontal Japanese text, and this fixation point was compared to the fixation point obtained using conventional microperimetry. The results revealed that the reading fixation point obtained using the new SLO software, which we designated the R fixation point, differed in many cases from the fixation point obtained through conventional microperimetry, which we designated the M fixation point.

This SLO software has since been improved, and Japanese text can now be projected running either horizontally or vertically, which has enabled us to investigate whether the fixation point changes during reading depending on the spatial orientation of the text. The purpose of this research was to determine if the R fixation point and the M fixation point are the same or if they differ between horizontal and vertical spatial orientation.

Reading in Japanese differs in many ways from reading in English. Specifically, Japanese can be written either horizontally or vertically, with computer-generated documents typically written horizontally and newspapers and novels more often written vertically. Moreover, three different sets of characters, hiragana, katakana, and kanji (Chinese characters) are employed, in contrast to the single, 26-letter alphabet of English. Word length also differs between Japanese and English. Thus, we felt it was important to investigate fixation points using Japanese text written both horizontally and vertically as a first step to improving the reading acuity of Japanese patients. While we cannot comment or make generalizations concerning other languages that might be similar to Japanese, such as Chinese, we feel that researchers in other languages would gain valuable insight into problems associated with their own specific language through similar research.

**Materials and Methods**

MNREAD-J text was projected onto the SLO screen using software as previously described. The text was projected both horizontally and vertically, and the character size was changed from a visual angle of 3.5° to 1.1° based on a six-step scale with a 0.1 log step. The position of the fixation point while the patient was reading aloud was recorded on video, which also permitted the simultaneous recording of the oral reading. The relationship between the fixation point and the retina was then determined. The retinal position during the reading of characters is referred to as the R fixation point. In addition, the fixation point was examined using conventional SLO microperimetry (ver. 3.01), and this fixation point is designated the M fixation point. The retinal sensitivity of the M fixation point was measured using microperimetry. The fixation target was in the shape of a ring, and the fixation point stimulation was directed to within this ring. An investigation was conducted to determine whether the R and the M fixation points were the same, whether the R fixation point shifted depending on the spatial orientation of the text or the character size, and the positional relationship between the R fixation point and the macular lesion.

A total of 17 patients participated in the testing, 11 men and 6 women. They ranged in age from 18 to 80 with a mean age of 57 and a visual acuity ranging from counting fingers to 1.2 (Table 1). The period from the onset of deterioration of visual acuity ranged from 1 to 36 years, and none of the patients had received eccentric fixation training. The diseases that caused the central scotoma in our patients are listed in Table 1. It should be noted here that central areolar choroidal dystrophy creates a bull’s eye pattern, and patients with this condition may actually have good visual acuity, with fixation possible in the bull’s eye area within the central scotoma. However, the area of good visual acuity can be quite small, and the patient can be classified as a poor reader. Such patients were included in our study. In addition, many of these patients had lesions that were not classified as an absolute scotoma because retinal atrophy in the lesion was not uniform but irregular in shape.

**Results**

The R and M fixation points were the same in 20 eyes and different in 11 eyes in these patients with bilateral macular atrophy. Fixation was not possible in three eyes. In all of the 11 eyes for which the R and M fixation points were different, the R fixation point shifted for horizontal versus vertical reading. In addition, the R fixation point shifted in five eyes in response to different character sizes for either horizontal or vertical reading, or for both.

The positions of the R and M fixation points for all patients are shown in Table 2. An examination of the R and M fixation points in each eye revealed that they were the same and, moreover, located within the lesion in 11 eyes. The fixation points changed in response to the three factors of spatial orientation of the text, character size, and object being viewed. For example, 12 eyes (1R, 1L, 4L, 6R, 8R, 9R, 9L, 11L, 12R, 13R, 14R, and 14L) were found to have an R fixation point on the nasal or temporal side when reading vertically, as shown in Table 2. Among these 12 eyes, the R fixation point was found not to change when reading horizontal text in 7 eyes, while it moved superiorly in 3 eyes and within the lesion in 2 eyes. In contrast, nine eyes (1R, 3R, 3L, 8L, 9R, 9L, 11R, 12L, and 17R) were found to have an R fixation point on the superior or inferior aspect when reading horizontally, and among these nine eyes, the R fixation point was found not to change when reading horizontal text in five eyes, while it moved nasally in one eye, temporally in one eye, and within the lesion in two eyes.