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ORIGINAL ARTICLE

The significance of changes in pupil size during straylight measurement and with varying environmental illuminance

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C-Quant straylight-meter;
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Abstract
Purpose: In this work, we investigated the pupillary conditions during straylight measurement, and the potential effect this might have on the measured straylight.
Methods: Five young (26–29-years-old) and 15 older (50–68-years-old) individuals participated in this study. First, the pupil diameter of both eyes was measured at three room illuminances. Next, straylight was assessed at two room illuminances. Simultaneously, the change in pupil size of the fellow eye was registered by a camera.
Results: Pupil size decreased with room illuminance and with age (both $p < 0.05$). The dependency of pupil size on age decreased as room illuminance increased (0.018 mm/year at 4 lux, 0.014 mm/year at 40 lux, and 0.008 mm/year at 400 lux illuminances). However, during straylight measurement, pupil sizes hardly differed between 4 and 40 lux illuminances. Respective pupil sizes corresponded with 399 and 451 lux adaptation on average. No statistically significant difference was found between the straylight under the two illuminances with average $R^2 = 0.85$, $p < 0.05$.
Conclusion: We conclude that the illuminance of the examination room during straylight assessment does not affect the outcome in normal eyes. In fact, under mesopic and scotopic conditions, the luminance of the test field is so much higher than that of the room so that it determines the pupil size. Regardless of the lighting level, straylight measured in a laboratory, is valid for photopic pupils at an adaptation level corresponding with about 400 lux room illuminance.

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PALABRAS CLAVE
Ojo;
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C-Quant straylight-meter;
Iluminancia ambiental

Importancia de los cambios del tamaño de la pupila durante la medición de la dispersión lumínica, con variación de iluminancia ambiental

Resumen
Objetivo: En este trabajo investigamos las condiciones de la pupila durante la medición de la dispersión lumínica, así como el efecto potencial que ello podría tener sobre la dispersión lumínica medida.
Métodos: En el estudio participaron cinco individuos jóvenes (de 26 a 29 años) y 15 mayores (de 50 a 68 años). En primer lugar, se midió el diámetro de la pupila de ambos ojos con tres iluminancias ambientales. A continuación, se evaluó la dispersión lumínica con dos iluminancias ambientales. De manera simultánea, se registró mediante una cámara el cambio del tamaño de la pupila del otro ojo.
Resultados: El tamaño de la pupila se redujo con la iluminancia ambiental y la edad ($p < 0,05$ para ambos). La dependencia del tamaño de la pupila con la edad se redujo a medida que aumentaba la iluminancia ambiental (0,018 mm/año a iluminancias de 4 lux, 0,014 mm/año a 40 lux, y 0,008 mm/año a 400 lux). Sin embargo, durante la medición de la dispersión lumínica, los tamaños de la pupila difirieron escasamente entre iluminancias de 4 y 40 lux. Los tamaños de la pupila respectivos se correspondieron con una adaptación de 399 y 451 lux, de media. No se encontraron diferencias estadísticamente significativas entre la dispersión lumínica bajo las dos iluminancias y la media de $R^2 = 0,85$, $p < 0,05$.
Conclusión: Concluimos que la iluminancia de la sala de examen durante la valoración de la dispersión lumínica no afecta al resultado en ojos normales. De hecho, en condiciones mesópicas y fotópicas, la iluminancia del campo de prueba es muy superior a la de la sala, lo cual determina el tamaño de la pupila. Independientemente del nivel de iluminación, la dispersión lumínica medida en un laboratorio es válida para pupilas fotópicas a un nivel de adaptación correspondiente a una iluminancia ambiental de alrededor de 400 lux.

Introduction

The amount of vision loss caused by disturbances in the eye's optical media can be assessed by visual acuity testing. However, these disturbances can also cause forward light scattering.[1–6] This scatter generates a veil of undesired light on the retinal image, leading to decreased image contrast and color, increased glare and hazy vision. Such increased glare becomes alarming often when the individual stops driving at night. The loss of contrast, on the other hand, may lead to difficulties such as against-the-light face recognition. The amount of straylight is expressed by a single-valued number, called straylight parameter. This parameter is the ratio between the undesired light scattered by disturbances in the optical media which generates the veil on the retina, and the desired non-scattered light, which forms the retinal image.

An issue that has been previously studied,[7] is the effect of pupil size on straylight. It might be thought that straylight is more bothersome at night, because the larger pupil size allows more light to enter the eye causing more glare. Therefore, it might be thought that the amount of straylight changes under low environmental light intensity. However, one should consider the fact that as the amount of scattered light increases by the enlarged pupil, the amount of constructive light entering the eye also increases. In other words, the ratio between the destructive and constructive light is approximately constant. The study by Franssen et al. concluded that the amount of straylight measured in a small group of dominantly young subjects with normal eyes (four subjects younger than 37 years and one 59 years old), only weakly depends on pupil diameter. Therefore, straylight values obtained in healthy young eyes under photopic conditions are valid for mesopic and scotopic conditions as well.

The crystalline lens changes with age. The lens grows over time and its color changes from clear to milky to yellow and then brown in eyes over 65 years of age. An old lens, even the clearest one, is a substantial source of straylight.[8] Early studies[9–11] on ocular straylight in normal eyes reported that it increased with age. Later, several studies[12–14] have confirmed that straylight increases with age; dominantly due to changes in the lens, even in normal eyes. A question then arises as to whether changes in the crystalline lens in older eyes that cause an increase in straylight, changes the straylight independency of the pupil size. As shown in several studies,[15,16] pupil size decreases with age and with environmental illumination. It is thought that the effect of partial eye wall translucency may be more important in small pupil sizes.[7] This trait of eye wall makes it another source of straylight.

In the present study, we wanted to find out what the pupillary conditions are during straylight measurement, and what potential effect this might have on the measured straylight value. In other words, we investigated whether pupil

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