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ORIGINAL ARTICLE

More sensitive correlation of afferent pupillary defect with ganglion cell complex

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KEYWORDS
Relative afferent pupillary defect;
Retinal nerve fiber layer thickness;
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Abstract
Purpose: This study investigated the correlation between the relative afferent pupillary defect (RAPD) and retinal nerve fiber layer thickness (RNFLT) in optic neuropathy.
Methods: RAPD assessment was performed using a log unit neutral density filter bar. Spectral domain optical coherence tomography RTVue-100 (Optovue) was used to examine the subjects. The optic nerve head pattern (ONH) was subdivided and identified for the purpose of the study into circumpapillary RNFLT (cpRNFLT) and peripheral circumpapillary RNFLT (pcpRNFLT). The cpRNFLT, pcpRNFLT and ganglion cell complex (GCC) parameters were analyzed.
Results: Eighteen females and twenty three males with asymmetric optic neuropathy and a RAPD participated. Thirty-three subjects had glaucoma and eight had optic neuropathy other than glaucoma. Significant correlations ($p < 0.02$) were obtained for the RAPD and the percentage difference loss of the GCC and RNFLT parameters. The grouped mean percentage difference loss for RNFLT was significantly different from that of the GCC ($p < 0.001$). At a 0.6 log unit RAPD, the average mean percentage difference loss was 23% for the CRNFLT, 15% for the GCC, 12% for the global loss volume percentage and 6% for the focal loss volume percentage (FLV%).
Conclusions: Significant correlations between RNFLT loss for cpRNFLT, pcpRNFLT and GCC parameters with RAPD were observed. Approximately a 35% higher sensitivity was obtained using GCC compared to CRNFL parameters. The expected change in GCC average for every 0.3 log unit increment was approximately 8.49 μm. The FLV% corresponded more sensitively to a RAPD but appeared to be influenced by disease severity.

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PALABRAS CLAVE
Defecto pupilar aferente relativo;
Grosor de la capa de fibras nerviosas de la retina;
Tomografía de coherencia óptica de dominio espectral;
Complejo de células ganglionares

Correlación más sensible entre el defecto pupilar aferente y el complejo de células ganglionares

Resumen
Objetivo: Este estudio investigó la correlación entre el defecto pupilar aferente relativo (DPAR) y el grosor de la capa de fibras nerviosas de la retina (RNFLT) en la neuropatía óptica.
Métodos: La valoración del DPAR se realizó utilizando una barra de filtro de densidad neutra de unidades logarítmicas. Para examinar a los sujetos se utilizó tomografía de coherencia óptica de dominio espectral RTVue-100 (Optovue). A los fines del estudio, se subdividió e identificó el patrón de la cabeza del nervio óptico (ONH) en RNFLT circumpapilar (cpRNFLT) y RNFLT circumpapilar periférico (pcpRNFLT). Se analizaron los parámetros de cpRNFLT, pcpRNFLT y del complejo de células ganglionares (GCC).
Resultados: Se incluyó en el estudio a dieciocho mujeres y treinta y tres varones con neuropatía óptica asimétrica y DPAR. Treinta y tres sujetos tenían glaucoma y ocho neuropatía óptica diferente a glaucoma. Se obtuvieron correlaciones significativas ($p < 0,02$) para DPAR y pérdida de diferencia porcentual de los parámetros GCC y RNFLT. La pérdida de diferencia porcentual media agrupada para RNFLT fue considerablemente diferente a la de GCC ($p < 0,001$). Para una unidad log de 0,6 de DPAR, la pérdida de diferencia porcentual media fue del 23% para CRNFLT, del 15% para GCC, del 12% para el porcentaje de volumen de pérdida global, y del 6% para el porcentaje de pérdida focal de volumen (FLV%).
Conclusiones: Se observaron correlaciones significativas entre la pérdida de RNFLT para los parámetros cpRNFLT, pcpRNFLT y GCC con DPAR. Se obtuvo aproximadamente un 35% de mayor sensibilidad utilizando los parámetros GCC en comparación a CRNFL. El cambio previsto en la media de GCC para cada incremento de unidad log de 0,3 fue de aproximadamente 8,49 um. El FLV% se correspondió de manera más sensible con DPAR, pero pareció verse influenciado por la severidad de la enfermedad.

Introduction

A relative afferent pupillary defect (RAPD) results from an afferent conduction deficit of the pupil light reflex yielding a relatively weaker efferent stimulation and pupil reactivity in the affected eye.[1,2] Optical coherence tomography (OCT) can quantify retinal nerve fiber layer thickness (RNFLT) and consequently provide a structural measurement estimate of retinal ganglion cell loss.[3–7] Results from time domain OCT (TD-OCT) studies have documented that approximately 25–27% RNFLT loss was associated with the presence of a RAPD and 23% at a 0.6 log unit RAPD compared to the contralateral unaffected eye.[3,7] Histological analysis in primates however, has documented similar percentage loss (25%) but composed exclusively of ganglion cells.[8,9] Studies using spectral domain OCT (SD-OCT) which allows for a higher scan rate and axial resolution of the retinal layers,[10,11] have also been used to establish a correlation with a RAPD.[8]

One brand of SD-OCT, the RTVue-100, Optovue combines the measurement of the RNFLT with that of the optic nerve head (ONH) by obtaining these values during a single probe. This SD-OCT feature improves the instrument's diagnostic potential compared to measuring each single parameter separately at a different time interval. The RTVue-100, Optovue also generates assessments of a quadrant area with a center located close to 1 mm temporal to the fovea. Within this area the instrument can more exclusively discriminate the ganglion cell from the total retinal layer using the protocol known as ganglion cell complex (GCC). The GCC measures the retinal thickness from the inner limiting membrane to the outer plexiform layer of the retina. The RNFLT at this retinal area is composed of the nerve fiber layer (NFL), the ganglion cell layer (GCL) and the inner plexiform layer (IPL). In this perifoveal region analyzed by the GCC, the NFL is very thin compared to the GCL and IPL. In addition, the GCC provides two calculated parameters; the global loss volume percentage (GLV%) and the focal loss volume percentage (FLV%). The GLV% provides an indication of average ganglion cell loss while the FLV% determines a pattern of focal loss of the retinal area measured by the GCC.[10,11] The GCC parameters have also been documented to be superior to RNFLT and other RTVue-100, Optovue values at detecting early structural glaucomatous changes.[12] The papillomacular bundle is mostly composed of parvocellular ganglion cell axons whose function primarily involves visual acuity, and also contributes to chromatic input and pattern stimuli processing. It is also considered that these fibers are mainly responsible for the pupillary reflex.[3–7,13] Consequently, the GCC protocol may contribute to a more specific assessment of the ganglion cell layer at this retinal quadrant and may assist in establishing a more accurate description of structural correlation with RAPD.

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