RECENT ADVANCES IN GLAUCOMA IMAGING

Essay

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LIST OF ABBREVIATIONS

ACA	Anterior chamber angle
AOD	Angle opening distance
ARA	Angle recess area
AROC	Area Receiver-operating characteristic
ARPs	Atypical retardation patterns
AS-OCT	Anterior segement optical coherence tomography
AUC	Area under the curve
CA	Cup area
CDR	cup-to-disc ratio
CDR	Vertical cup / disc ratio
CP RNFL	circumpapillary retinal nerve fiber layer
CSLO	Confocal scanning laser ophthalmolscopy
CV	Cup volume
DIGS	Diagnostic Innovations in Glaucoma Study
ECC	Enhanced corneal compensation
EDI	Enhanced Depth Imaging
GCC	Ganglion cell complex
GCL	ganglion cell layer
GPA	guided progression analysis
GPS	Glaucoma Probability Score
HRT	Heidelberg Retina Tomography
IPL	Inner plexiform layer
IRC	Inner retinal complex
LPI	Laser peripheral iridectomy
mNFL	Macular nerve fiber layer
MR	Macular retinal
MRA	Moorfields Regression Analysis
NFI	Nerve fiber layer
NRA	Neuroretinal rim area
NTG	Normal tension glaucoma

OCT	Optical coherence tomography
ONH	Optic nerve head
ONHP	Optic nerve head photography
PACG	primary angle-closure glaucoma
POAG	primary open-angle glaucoma
PSD	pattern standard deviation
RADAAR	Rim area to disc area asymmetry ratio
RGC	retinal ganglion cell
ROC	Receiver-operating characteristic
SD-OCT	Spectral-domain optical coherence tomography
SL-OCT	Slit-lamp optical coherence tomography
SLP	Scanning laser polarimetry
TSNIT	Temporal-superior-nasal-inferior-temporal
UBM	Ultrasound biomicroscopy
VCC	Variable corneal compensation

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INTRODUCTION

Glaucoma is a multifactorial, progressive, neurodegenerative disorder. It is characterized by the death of retina ganglion cells with damage in the retinal nerve fiber (RNFL) and characteristic optic nerve atrophy if left untreated. **(1).**

Recent technological advances that have emerged enable more precise identification and quantification of glaucomatous damage and facilitate early glaucoma diagnosis and monitoring of progression. Hence early diagnosis is crucial and is possible due to advances in both functional and structural investigative techniques. **(2).**

Functional investigative techniques such as short-wavelength automated perimetry (SWAP) (Humphrey Systems, Dublin, California) has shown potential for earlier detection of glaucomatous visual field defects and more sensitive assessment of visual field progression. The test uses a bright yellow background with blue stimuli. SWAP requires detection by the short-wavelength cones and processing through the small bistratified ganglion cell (blue-yellow). Frequency doubling technology (FDT) perimetry (Welch Allyn, Skaneateles, New York, and Humphrey Systems, Dublin, California). FDT isolates a subgroup of retinal ganglion cell mechanisms in the magnocellular (M-cell) pathway, Which has function that are recognized to be abnormal in glaucoma.**(3).**

Structural investigative technique include optical coherence tomography (OCT), confocal scanning laser ophthalmoscopy (CSLO) scanning laser polarimetry (SLP) provide objective and quantitative measurements that are highly reproducible and show good agreement with clinical estimates of optic nerve head structure and visual function. **(2).**

OCT is of particular utility in glaucoma, since it provides high-resolution objective, quantitative assessment of the retinal cellular layers affected by the disease. The recent availability Spectral Domain Optical Coherence Tomography SDOCT has permitted visualization of multiple intra retinal layers. Investigating the involvement of photoreceptor is pertinent to understanding the extent of retinal damage in glaucoma patients and developing new psychophysical tests for glaucoma detection. SDOCT measures RNFL thickness with a low-coherence light source projected onto the retina. The time delay of the light backscatter from the RNFL compared with light reflected by a reference mirror is then calculated. Circumpapillary RNFL was measured in the fast RNFL mode using three 360-degree circular, high-resolution scans with a diameter of 3.4 mm that were centered on the optic disc. RNFL thicknesses of the collective quadrants (360° measure), as well as the individual temporal (316°-45°), superior (46°-135°), nasal (136°-225°), and inferior (226°-315°) quadrants, were obtained for analysis **(4).**

CSLO is a non–invasive investigation that has been used initially to receive three–dimensional images of the retinal surface in vivo. The commercial name of the device is Heidelberg Retina Tomograph (HRT). Two variants are used in current practice: HRT Ⅱ and HRT Ⅲ and used for the analysis of the optic disc and peripapillary retinal nerve fibers layer. HRT is designed to scan the retinal surface with a diode laser, which has a wavelength of 670 nm. The precision of the method is based on the principle of confocality, thus only the laser light reflected from the focal plane, which focuses at the level of the diaphragm, is allowed to pass and it is registered by the detector. **(5)**

SLP takes advantage of the birefringence property of the RNFL that modifies the polarization of the light (retardation) when illuminated. The retardation is proportional to the thickness of the birefringent tissue, thus allowing the instrument to obtain objective and quantitative measurements of the RNFL thickness. The reliability of the measurements is dependent, at least in part, on the machine’s ability to extract the RNFL retardance from the total ocular retardance, since the cornea and the lens also exhibit some degree of birefringence. The commercially available SLP instruments are the GDx VCC (variable cornea compensation) and the latest GDx ECC (enhanced corneal compensation), which overcome the corneal birefringence. **(6).**

Ultrasound biomicroscopy (UBM) and anterior segement optical coherence tomography (AS OCT) is used for assessment of the anterior segment in glaucoma. UBM systems use frequencies ranging from approximately 35 to 80 MHz, as compared with typical 10-MHz systems used for general-purpose ophthalmic imaging.AS OCT is a light-based imaging modality that provides high-resolution images of the anterior segment in cross section. It allows for an objective assessment of the anterior chamber (AC) angle by a completely noncontact approach. AS-OCT has undergone several advances, including the use of 1.3-μm-wavelength light and the development of high-speed imaging at this wavelength. These modifications have improved the visualization of AC angle structures and enabled real-time imaging of changes in the angle configuration. Both technologies allow visualization of the iridocorneal angle and thus, can contribute to the diagnosis and management of glaucoma. **(7).**

Aim of work

This work aims at reviewing the current status of advanced imaging techniques in management of glaucoma.