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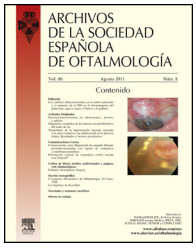

Review

Current interpretation of optical coherence tomography in the posterior pole☆

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ABSTRACT

Objective: To review the literature in order to describe the current nomenclature for the interpretation of retinal images of optical coherence tomography (OCT) in the macular area.
Methods: A comprehensive literature search was conducted in the major biomedical databases since the introduction of OCT in ophthalmological field.
Results: Quantitative variations of central macular thickness and proper terminology used throughout the years are directly related to the technology and equipment used.
Conclusions: The current nomenclature of normal macular architecture represented *in vivo* on spectral domain OCT technology provides a clear and valid anatomical interpretation that can be applied, not only in research, but also in everyday practice.

Interpretación actual de la tomografía de coherencia óptica en el polo posterior

Palabras clave:
Capas retinales
Espesor macular central
Tomografía de coherencia óptica
Polo posterior

RESUMEN

Objetivo: Realizar una revisión bibliográfica para describir la nomenclatura actual en la interpretación de las imágenes retinales de la tomografía de coherencia óptica (OCT) en el área macular.
Métodos: Búsqueda exhaustiva de la bibliografía en las principales bases de datos biomédicas desde la introducción de la OCT en el campo oftalmológico.
Resultados: Las variantes cuantitativas del espesor macular central y la terminología utilizada a lo largo de los años está en relación directa con la tecnología y el equipamiento utilizado.

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Conclusiones: La nomenclatura actual de la arquitectura macular normal representada en imágenes en vivo por la tecnología de OCT de dominio espectral nos proporciona una clara y válida interpretación anatómica para aplicarla no solo en proyectos de investigación, sino en la práctica diaria.

Introduction and history

Optic coherence tomography (OCT) is the biggest technological development of recent years in modern ophthalmology. It has become the diagnostic method of choice for analyzing and following up diseases involving the retina and optic nerve.

OCT is a noninvasive, contactless device that captures *in vivo* images of the retina. In addition it is characterized by an encouraging evolutionary capacity based on continuously evolving technologies. It is likely that in the not too distant future it may produce perfect histological digital sections with sufficient resolution to exceed in detail and durability histological retina sections obtained from cadavers.

Before OCT, ocular image technologies did not provide sufficient depth resolution for the posterior segment and there was no equipment capable of producing anatomical cross-sections of the retina.[1–3] In 1991, a group of researchers of the Massachusetts Institute of technology (Boston, MA, USA) under the leadership of Dr. J. Fujimoto developed the initial prototype of OCT, giving rise to the necessity of developing applications as well as an adequate exploration field for developing this novel technology. In said year, the same group of researchers[1] demonstrated that this new technology was able to provide images of human biological microstructural tissue with the certain possibility of application in some branches of medicine, as shown very shortly thereafter in cardiology and particularly ophthalmology.[1] Said authors described a system based on low coherence interferometry with time and domain technology (TD-OCT) that was able to obtain sequences of images with a resolution of 17 μm, requiring 1.25 s to complete an A scan.[1] However, this system required 150 A scans to render a single image, involving 190 s. In the first trials with OCT, axial section retinal images were obtained *in vitro*, i.e., cadaver eyes were used as experimental models (*in vitro* specimens) (Fig. 1). The first paper on OCT was published on the basis of these findings. Said paper described the visualization of internal tissue microstructures through bidimensional images *in vitro*, both of the coronary artery and the peripapillary region of the retina. This was clinically and scientifically very relevant for the time and marked the beginning of a transcendental change in the development of modern day ophthalmology.[1]

The first *in vivo* image of the retina was obtained simultaneously by 2 independent research groups that presented a system for acquiring these images at higher scan rates and lower tissue exposure time. This development took place in 1993, with demonstrations being published by Fercher et al.[3] and Swanson et al.,[4] respectively. Since then, with the encouragement of positive results, research continued in an endeavor to extrapolate these findings to the general population. Accordingly, the first device for visualizing the posterior segment

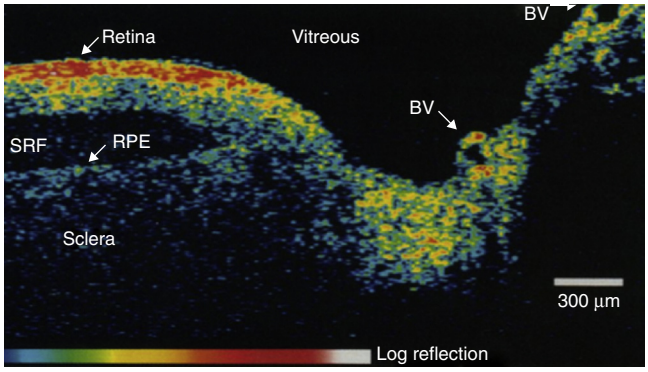

Fig. 1 – *In vitro* optic coherence tomography (OCT) of a human retina. Tomographic prototype image presented in 1991. The image corresponds to a section of the retina and the optic nerve over the papillomacular bundle of a cadaver eye.
Reprinted with the authorization of Huang et al.[1]

in vivo was marketed in 1995 (Humphrey Instruments, Dublin, USA). In a very short time, the technology was transferred to the industry and introduced into the market for ophthalmological use in 1996 (Carl Zeiss Meditec, Dublin, USA).

Also in 1996, Hee et al.[5] described the clinical application of OCT as a diagnostic tool and introduced a faster scanner capable of performing 100 A scans in only 2.3 s. However, the definitive worldwide expansion began 5 years later with the arrival in the market of a 3rd generation of devices achieving a revolutionary image resolution of 15 μm and a rapid scanning acceleration of 400 A scans per second. The market name of the product was Stratus, by Carl Zeiss (Stratus OCT; Carl Zeiss Meditec, Dublin, USA). Widespread acceptance by ophthalmologists was immediate and since then everything related to this tool has evolved very positively. In 2006, high definition systems were developed with the appearance of spectral domain technology (SD-OCT) with devices such as Cirrus HD Spectral Domain (Carl Zeiss-Meditec, Dublin, USA) or equivalent devices like Spectralis OCT (Heidelberg Engineering, Vista, USA), Topcon 2000 3D (Topcon Corporation, Tokyo, Japan), Optovue (Optovue Inc., Fremont, USA) as well as new emerging industries. Since this breakthrough in the ophthalmological field, devices equipped with the latest SD-OCT technology have become the natural successors of TD-OCT devices. The difference in the anatomical details observed in the scans is so remarkable that the formally revolutionary resolution provided by TD-OCT is now virtually obsolete. Even so, at present these devices continue to be sufficient as diagnostic tools for general ophthalmologists. SD-OCT, with an axial resolution between 3 and 10 μm