Bratisl Lek Listy 2010; 111 (5)
306 – 307

REVIEW

Optical coherence tomography – a new imaging method in ophthalmology

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Abstract: An improvement of examination methods in ophthalmology, technical digitalisation and knowledge of validity of examinations in various diseases contributes to early diagnostics, thereby leading to an opportunity for early treatment of eye disorders. Standard introduction of the so-called optical coherence tomography into the ophthamological clinical practice facilitated new options for a detailed analysis of pathological processes in the particular layers of the retina *(Fig. 2, Ref. 5).* Full Text (Free, PDF) *www.bmj.sk.*
Key words: diagnostics of eye diseases, optical coherence tomography.

Optical coherence tomography (OCT) is a new non-invasive imaging technique that enables a precise tomographic analysis of biological structures in vivo. OCT has become a leading imaging method, particularly useful in displaying the structures of the eye requiring projection of micrometric proportions and a penetration depth of several millimetres. Nowadays, OCT is one of the most important tools in the management of a variety of disorders of the macular region of the retina. It enables to create a three-dimensional "non-invasive optical histology in vivo" delineating the microstructural morphology of retina that till now has been possible only by histopathological means (1).

OCT displays a cross section of the inner microstructure of biological tissue at a high resolution (Fig. 1). Using a low-coherent light it delivers images and a B-mode picture shows the cross section of retina as an output. The B-mode consists of consecutive A-mode images that are formed on the basis of time-delay and reflected light or scattered light measurements (2).

OCT enables a precise measurement of volumes and distances in all retinal and sub-retinal spaces. It shows the precise volume and configuration of intra-retinal cysts, macular holes, photoreceptor layer, intra-retinal and sub-retinal fluid and vitreomacular region.

Several scientific groups worldwide performed interferometric research using white light that allowed non-invasive imaging of biological tissues in vivo. Fujimoto et al (4) used OCT for the investigation of biological tissues for the first time in 1990. In 1991, OCT with an axial resolution of 30 µm was presented. In 2001, the resolution reached less than 1 µm thanks to the introduction of a wide-spectrum source of light emitting 1000 nm wavelengths, thereby facilitating structural resolution down to the cellular level (Fig. 1).

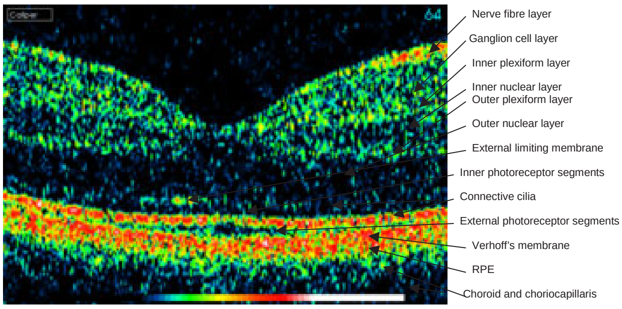

Fig. 1. B-mode OCT: Physiological image of macular region of the retina that shows individual retinal layers in the macular region.

How OCT works

A defined source of light (a high luminous intensity diode) provides light with a wavelength above 1000 nm that is consequently divided in two separate beams with 1:1 ratio. One beam is directed at the tissue being examined and the device compares its reflected part, which is dependent on the tissue structure reflectivity, with the second beam reflected from a reference mirror. The emerging signal, corresponding to the interference of these two reflected beams, is then processed by a computer into a final pseudo-coloured scale image that matches the histological image of the retina. The colour of the displayed retinal layers and choriocapillaris depends on their reflectivity. The layers of hyperreflectivity – physiological choriocapillaris, pigmented epithelium of the retina, connective cilia of the inner and outer segments of photoreceptors and nerve fibre layer – are displayed in red and white colours. In the blue and black colour spectra are displayed the layers of hyporeflectivity – large chor-

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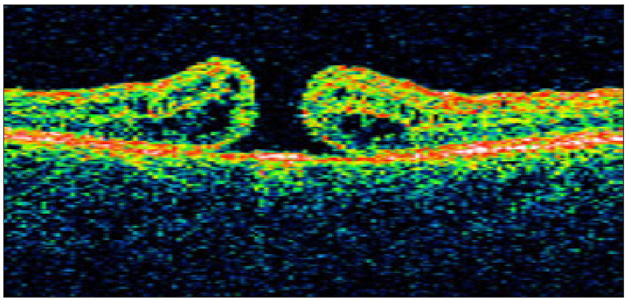

Fig. 2. B-mode OCT: Macular hole.

oid vessels and physiological vitreous humour. In yellow and orange tones are the other layers of the retina displayed. The images obtained are evaluated and registered using software, which helps in comparing the progression of the disease over time, follow-up of preoperative and postoperative findings or in evaluation of treatment results. The graphical image of the macula is displayed as six sections in the form of a map with colour discrimination of regions with the same thickness. OCT has also been used for obtaining images of the optic nerve head (ONH) and retinal nerve fibre layer (RNFL). OCT compares the RNFL in relation to patient's gender and age using a database of normative data. The examination is fast, simple and non-invasive.

Conclusion

Nowadays, OCT is one of the most important tools in the management of eye disorders, mainly in the macular region of the retina (3). OCT provides higher magnification than the conventional clinical imaging modalities such as ultrasound, magnetic resonance or computerised tomography. Since its creation in 1990, the optical coherence tomography has been tested in a number of clinical applications (5).

OCT facilitates establishment of an early diagnosis of retinal diseases such as macular oedema, epiretinal membrane or macular hole (Fig. 2), thereby providing the opportunity for early treatment. It enables better understanding of the pathophysiology and treatment results of individual pathological processes of the retina.

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Received June 26, 2009.
Accepted February 3, 2010.