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Evaluation of corneal changes in chemical burns with anterior segment optical coherence tomography

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Keywords

anterior segment, optical coherence tomography, cornea, ocular injury

Abstract

Aims: Chemical injuries of the anterior segment of the eye are a common problem and may cause a serious damage to the eye. Proper management in the acute setting, as well as follow up examination and evaluation is crucial in limiting adverse effects of ocular tissue damage. Purpose: To present the application of anterior segment optical coherence tomography (AS-OCT) evaluation of the corneal changes in patients with chemical injuries.

Patients and Methods: Retrospective non comparative series of 17 eyes in 14 patients who were evaluated and treated at the University Eye Clinic Skopje. The Topcon SL Scan 1 and color photography were used in each injured eye, OCT-AS scanning was performed at the first examination and the follow up examination. All scans were carried out with scanning beam passing through the centre at specific meridians. Quantitative parameters of the corneal thickness were also investigated. Color photography was correlated with OCT findings.

Results: A characteristic AS-OCT images of the cornea ex vivo is shown. The epithelial and endothelial layers, the stromal fibers are distinguished. Also OCT images of the corneal tissue damage caused by chemical interaction are presented.

Summary: We showed that the AS-OCT is capable of imaging and evaluation of chemical injuries in real time. It was demonstrated that AS-OCT is sensitive to the changes in the structural properties of the cornea as a result of the chemical damage.

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Introduction

Chemical injuries to the eye represent one of the true ophthalmic emergencies. While almost any chemical can cause ocular irritation, serious damage generally results from either strongly basic (alkaline) compounds or acidic compounds. Alkali injuries are more common and can be more deleterious (1).

For chemical burns a considerable lack of methods exists for defining penetration kinetics and effects of decontamination within biological structures. We demonstrate that optical coherence tomography can close this gap by monitoring changes.

Anterior segment optical coherence tomography (AS-OCT) was recently developed and has become a crucial tool in clinical practice. AS-OCT is a noncontact imaging device that provides the detailed structure of the anterior part of the eyes (2, 3).

OCT provides high-resolution images of biological tissue using the interference between incident and returning (reflected or backscattered) light to obtain structural information that can be used to distinguish between injured cornea and healthy cornea. A particularly important use is to distinguish benign and severe burns by means of Descement membrane.

Chemical burns invariably cause damage to the surface epithelium as well as to the stromal matrix. The persistence of active fibroblasts in some of the tissues is a proof of ongoing stromal changes, long after the primary damage from chemical burns. The initial influx of polymorph-nuclear cells and direct damage of the stromal matrix and fibroblasts could possibly trigger off a vicious cycle of inflammation, wound repair and fibrosis. The damage to the corneal and conjunctival epithelium from an ocular burn may be so severe as to damage the pluripotent limbal stem cell causing a limbal stem cell deficiency. This may lead to opacification and neo-vascularization of the cornea (1, 4).

The importance of phospholipids in the structure of cell membranes of the cornea is crucial damage to the cytoplasmic membrane the disintegration of the three-dimensional configuration of the protein (5).

The purpose of this article is to present the application of AS-OCT evaluation of the corneal changes in patients with chemical injuries. To evaluate the characteristics of abnormal corneal lesions with slit-lamp biomicroscopy and digital photography with good resolution and correct contrast of various grade of corneal chemical burns.

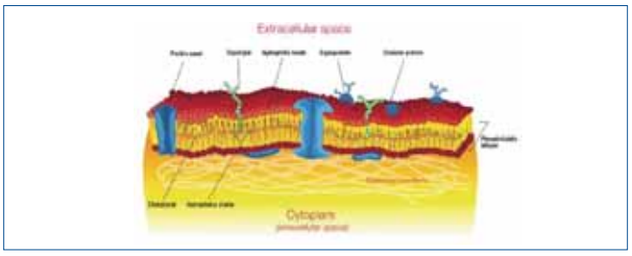

Fig.1 Structural changes in chemical ocular burn injuries

Patients and Methods

We analyze retrospective and non-comparative series of 17 eyes in 14 patients who were evaluated and treated at the University Eye Clinic Skopje.

The Topcon SL Scan 1 FD (840 nm) and color photography were used in each injured eye, OCT-AS scanning was performed at the first examination and next ones. All scans were carried out with scanning beam passing through the center at specific meridians. Color photography was correlated with OCT findings.

The SL SCAN-1 uses a Fourier Domain OCT system (SLD light source, central wavelength 840 nm, bandwidth 30 nm, 1024 pixel CCD camera, resolution in tissue 8 to 9 micron, scan speed 5000 A-scans per second,). The fast scanning speed, with 512 a-scans per B-scan, allows a full B-scan to be made in approximately 0.1 seconds.

Results

The AS-OCT findings of patients suffering from acute chemical injury were as follows: anterior stromal hyper-reflectivity, epithelial edema, and irregular breaks in the epithelium.

Undetected epithelial basement membrane, intraepithelial inclusions, and anterior stromal hyper-reflectivity were seen in patients with corneal scars. These findings correlated well with the clinical symptoms.

AS-OCT presented clear visualization of the fibro-vascular pannus as an irregular hyper-reflective layer and hypo-reflective area of differing diameter.

Discussion

Various corneal changes (Figures 1 and 3) can occur and AS-OCT can be helpful in detecting these conditions. OCT works on the principle of low coherence interferometry (2, 3). First clinical impressions in patients with chemical injury present new precise understanding of this serious problem. (5)

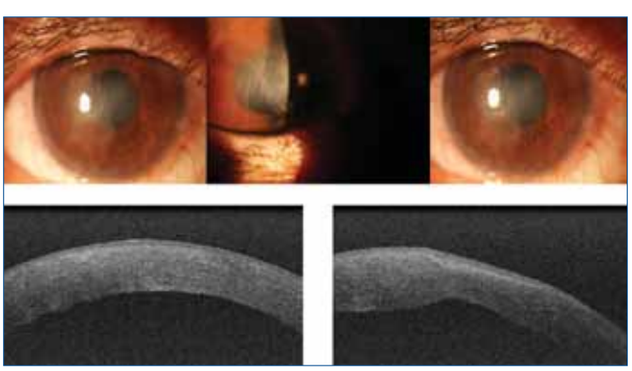

Figure 2. Anterior segment photography and AS-OCT image in old injured with $CaCO_3$

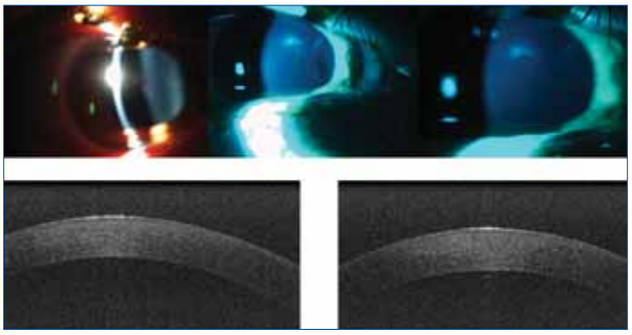

Figure 3. Horizontal AS-OCT and digital photography in 35 years old patient injured with $NaOH_2$

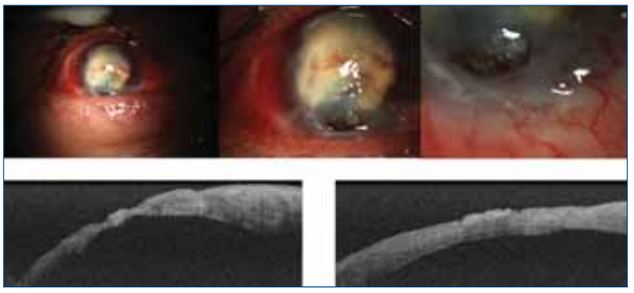

Figure 4. Anterior segment photography and horizontal AS-OCT images of corneal melting, intrastromal deposits after old KP

This study demonstrated the proof of principle that the AS-OCT scans can obtain all structures of cornea and anterior chamber, to examine lesions and provide detailed cross-sectional image. Also these images will provide additional information about corneal neovascularization, thickness and tears meniscus (6, 7).

Conclusions

We showed that the AS-OCT is capable of imaging and evaluation of chemical injuries in real time. It was demonstrated that AS-OCT is sensitive to the changes in the structural properties of the cornea as a result of the chemical damage. The result from implementing the AS-OCT will be useful for evaluating and planning the urgent management and treatment. We can follow "in-vivo" evolution of chemically severely-injured, preventing complications and educate of young ophthalmologists.

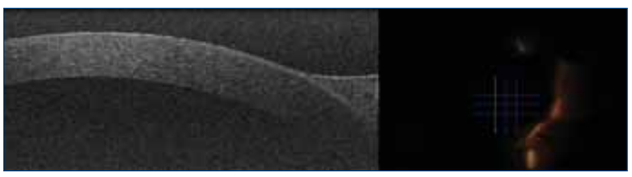

Figure 5.Tears meniscus measurement by AS-OCT (TMD-depth and TMA-area) injured by H2SO4 25%

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