Report on speckle-noise freed choroidal angiography and virtual tumouropsy using optical coherence tomography

Introduction

Pigmented tumors of the posterior pole may represent a major impact on a patient’s life and a diagnostic hurdle for the treating ophthalmologist. In 1987, the Collaborative Ocular Melano-

oma Study Group published important predictive factors of growth. Shields offered guidelines in the assessment and management of posterior uveal melanoma and evidence grew, that smaller sized tumors may show a potentially better outcome.

However, even clinically small tumors may express gene instability as monosomy 3, loss of 6q and 8q and be prone for malignant transformation and hematogenous diseases. Most patients die within one year after metastasis are detected.

Posterior uveal tumors are mostly identified using indirect ophthalmoscopy. Color fundus photography has shown to be of great importance in diagnosis and monitoring of uveal tumors and is used today as a widespread technology. Additional methods as ultrasonography, autofluorescence or fluorescence angiography may help to further clarify the diagnosis.

Fine-needle aspiration would be of priceless value, but is performed only in specific cases, because of the deli-

crate intraocular location. However, despite the great successes in imaging of choroidal tumors, the access has been limited because of technical limits.

In recent years, advances in optical coherence tomography (OCT) have improved imaging of the retina and of the choroid as well. This progress is of great importance, since about 80% of uveal melanomas are originated in the choroid. Many difficulties of OCT as motion artifacts, signal loss, and relative long acquisition times, respect-

ively, which were successfully addressed using enhanced-depth imaging OCT, image averaging or the use of a longer wavelength as 1050 nanometer swept source OCT.

A major problem that occurs in almost all imaging modalities such as OCT, computer-tomography (CT), magnetic resonance imaging (MRI) or ultrasonography (US), is speckle noise, that may obscure and blur the signal. Many noise filters have been described, but so far have not signifi-
cantly been introduced in medical imaging. Therefore, in our OCT labo-

ratory of the University of Basel, we have tried a specific approach and focussed not on the noise, but on the OCT signal.

Methods

A novel, post-processing, three-

dimensional motion vector field algo-

rithm was developed to track an OCT signal per pixel per pixel over an acquired OCT volume in all three dimensions. This resulted in a significant noise reduction in all directions and preser-

vation of retinal and choroidal struc-

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normalization and contrast enhancement, subsequent threshold-filtering of choroidal vessels enabled extraction of choroidal ves-

sels and tissue.

According to the international nomenclature for optical coherence tomography, hyperreflective choroidal areas were defined as vessels and hyperreflective structures as tissue.

Results and discussion

Ocular tumors may show a significant threat to a patients vision. Therefore, diagnosis at an early stage would be desired. Speckle-noise removal was obtained in choroidal nevi from patients suffering from choroidal tumors. The method allowed a non-invasive, non-


contact speckle-noise freed OCT cho-

roidal angiography and choroidal tumouropsy. Results of speckle noise removal are shown in Figures 1-3.

As a post-processing method, the described algorithm may be used on all standard spectral-domain or advanced 1050 nanometer OCT sys-

tems and liberate the OCT signal from noise and provide further enhanced imaging of all ocular tumors. The limi-
tation of speckle-noise removal are the relatively long rendering time in all three dimensions, the need for a rela-

tive high number of cross sectional images, and the impossibility to use the technology described for the anal-

ysis of a single layer image. Further-

more, the new method has to be vali-
dated in new studies.

However, the proposed algorithm may allow a novel approach in the qualitative and quantitative assess-

ment of ocular tumors and other ocul-

ary diseases, such as choroidal metastic retin-

opathy, glaucoma or age-related macular degeneration (AMD).

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Disclosure of potential conflicts of interest

Dr. Peter Mäslka and Cyril Gyger are owner of intellectual property on speckle-noise analysis discussed in this publication. Dr. Peter Mäslka and Dr Hasler are consultant of Mediconsult/Topcon but the organization had no role in the design or conduct of the presented manu-

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