Department of Ophthalmology
Faculty of Medicine - Ain Shams University

Optical Coherence TomographyAngiography (OCTA) as a New Modality for Posterior Segment Imaging

Essay

Submitted for partial fulfillment of M.Sc degree in Ophthalmology

BY

Mai Mohamed Fathi Beheri

M.B, B.Ch,

Under Supervision of

Prof. Dr. Sherif Zaky Mansour

Professor of Ophthalmology

Faculty of Medicine — Ain Shams University

Dr. Thanaa Helmy Mohamed

Assisstant Professor of Ophthalmology

Faculty of Medicine — Ain Shams University

Dr. Rania Gamal El-din Zaki

Lecturer of Ophthalmology

Faculty of Medicine — Ain Shams University

Faculty of Medicine — Ain Shams University

Cairo –Eygpt,

2016

I would like to begin by thanking ***ALLAH*** for his guidance and protection, may this blessing always guide us.

From my heart, I would like to express my profound gratitude and my sincere thanks and appreciation to ***Prof. Dr. Sherif Zaky Mansour***, Professor of Ophthalmology, Faculty of Medicine, Ain Shams University, ***Dr. Thanaa Helmy Mohamed*** , Assistant professor of ophthalmology, Faculty of Medicine , Ain Shams University , and ***Dr. Rania Gamal El-din Zaki*** , Lecturer of ophthalmology, Faculty of Medicine ,Ain Shams University for their kind supervision, immeasurable support, endless encouragement invaluable advices and helpful directions throughout the whole work.

Mai Mohamed Beheri

List of Contents

List of abbreviations

AMD	Age related macular degeneration
BM	Bruch's membrane
BRAO	Branch retinal artery occlusion
CNV	Choroidal neovascularization
CRAO	Central retinal artery occlusion
CSC	Central serous chorioretinopathy
DM	Diabetes mellitus
DME	Diabetic macular edema
DR	Diabetic retinopathy
EDI	Enhanced-depth imaging
ETDRS	Early treatment diabetic retinopathy study
FA	Fluorescein angiography
FAF	Fundus autofluorescence
FAZ	Foveal avascular zone
GA	Geographic atrophy
GCL	Ganglion cell layer
ICGA	Indocyanine green angiography
ILM	Internal limiting membrane
INL	Inner nuclear layer
IOP	Intra ocular pressure
IPL	Inner plexiform layer
IS	Inner segment
NPDR	Non proliferative diabetic retinopathy
NVD	Neovascularization of the disc
NVE	Neovascularization elsewhere
OCT	Optical coherence tomography
OCTA	Optical coherence tomography angiography
ONH	Optic nerve head
OPL	Outer plexiform layer
OS	Outer segment

PCV	Polypoidal choroidal vasculopathy
PDR	Proliferative diabetic retinopathy
PPG	Preperimetric glaucoma
RAO	Retinal artery occlusion
RAP	Retinal angiomatous proliferation
REP-1	Rab escort protein 1
RNFL	Retinal nerve fiber layer
RNV	Retinal neovascularization
RPC	Radial peripapillary capillary
RPE	Retinal pigment epithelium
RPED	Retinal pigment epithelial detachment
SD-OCT	Spectral domain optical coherence tomography
SRD	Serous retinal detachment
SSADA	Split-spectrum amplitude decorrelation angiography
SS-OCT	Swept-source optical coherence tomography
TD-OCT	Time domain optical coherence tomography
VCSEL	Vertical cavity surface emitting laser

List of Figures

Introduction

Retinal vascular diseases are a leading cause of blindness. Optical coherence tomography (OCT) has become the standard imaging modality for evaluating fluid accumulation in these diseases and for guiding treatment. However, fluorescein angiography (FA) is still required for initial evaluation of retinal ischemia and choroidal neovascularization, which are not visible in conventional structural OCT. As a non-invasive three - dimensional alternative, OCT- angiography may be used in routine screening and monitoring to provide new information for clinical diagnosis and management. [1, 2].

Optical coherence tomography angiography (OCTA) is a new noninvasive imaging technique that employ motion contrast imaging to high-resolution volumetric blood flow information generating angiographic images in a matter of seconds. [3, 4, 5, 6].

Published studies hint at OCTA's potential efficacy in the evaluation of common ophthalmologic diseases such age related macular degeneration (AMD), diabetic retinopathy, artery and vein occlusions, and glaucoma ,which are the major causes of blindness .[1, 7].

OCT-angiography can detect changes in choroidal blood vessel flow and can elucidate the presence of choroidal neovascularization (CNV) in a variety of conditions but especially in age-related macular degeneration (AMD) [8, 9,10].

The method of angiography based on Split-spectrum amplitude - decorrelation angiography (SSADA). It uses the natural flow as the target of the algorithm, and then, it doesn't need any injection of any dye to obtain the image of retinochoroidal vascular network. [11]

OCT- angiography compares the decorrelation signals (differences in the backscattered OCT signal intensity or amplitude) between sequential OCT b-scans taken at precisely the same cross-section in order to construct a map of blood flow. Axial bulk motion from patient movement is eliminated so sites of motion between repeated OCT b - scans represent strictly erythrocyte movement in retinal blood vessels. [12].

OCT angiography in comparison with other techniques like Fluorescein angiography (FA) and Indocyanine green angiography (ICGA) is a non- invasive technique that acquires volumetric angiographic information without the use of dye. Each three - dimensional scan set takes approximately six seconds to obtain OCT angiography provides flow information at a fixed point in time. While other techniques are both invasive test that require intravenous administration of dye and imaging up to 10 - 30 minutes. They provide two - dimensional image sets that allow for dynamic visualization of blood flow with a wide field of view, they are invasive, relatively expensive, and time-consuming , they are not ideal techniques to use on a regular basis in a busy clinical setting .[13,14,15].

Both the retinal and the choroidal microvasculature can be visualized using OCT angiography while Fluorescein angiography (FA) is used for seeing the retinal vessels and Indocyanine green angiography (ICGA) is more ideal for imaging the choroid. [16].

Physics and Principles of OCT and OCT Angiography

Optical coherence tomography:

Optical coherence tomography (OCT) is an imaging system designed to acquire high resolution cross-sectional retinal images. The technique is analogous to ultrasonography, but the tomographic OCT image is an intensity map of light back-scattered or reflected from tissue structures. [17]

Optical Coherence Tomography can essentially be thought of as a sort of " Ultrasound with light ".In ultrasound imaging ,sound echoes are measured ,While OCT measures the echoes of back-scattered light after passing through a sample.[18]

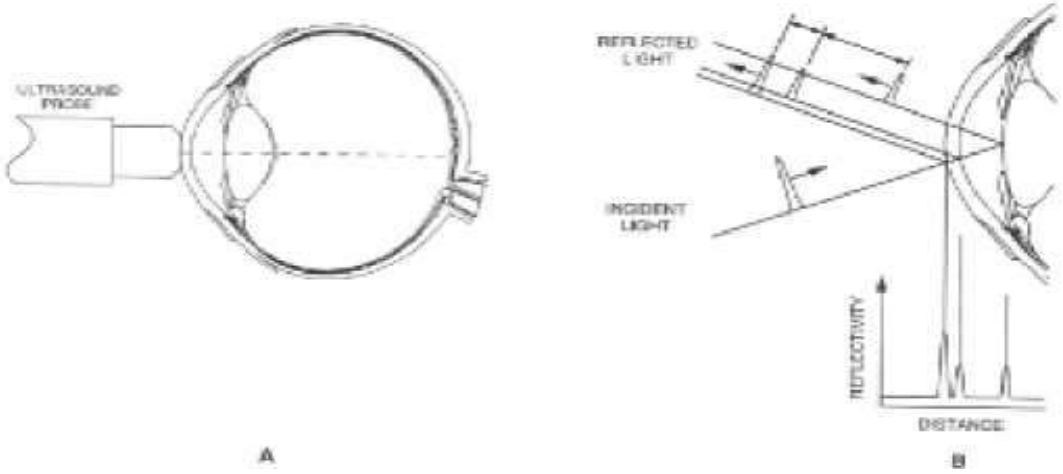

Figure (1): Ultrasound axial measurement (A-mode) and imaging (B- mode) require direct contact with the eye (A), while optical axial imaging have higher resolution than ultrasound and do not require direct contact with the eye (B). [19].