



Comparison of Anterior Segment Optical Coherence Tomography and Ultrasound Biomicroscopy for Assessment of the Anterior Segment of the Eye

Essay

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List of Abbreviations

OCT	:	Optical coherence tomography
UBM	:	Ultrasound biomicroscopy
AS-OCT	:	Anterior segment OCT
SD-OCT	:	Spectral-domain OCT
TD-OCT	:	Time Domain OCT
FD-OCT	:	Fourier Domain OCT
OFDI	:	Optical Fourier domain imaging
SS-OCT	:	Swept-source OCT
LASIK	:	Laser-assisted in situ keratomileusis
RADAR	:	RAdio Detection And Ranging
SLD	:	Super luminescent diode
ANSI	:	American National Standards Institute
RSOD	:	Rapid scanning optical delay
IOP	:	Intraocular pressure
ONH	:	Optic nerve head
GON	:	Glaucomatous optic neuropathy
POAG	:	Primary open-angle glaucoma
ACA	:	Anterior chamber angle
ACD	:	Anterior chamber depth
CB	:	Ciliary body
PD	:	Pupil diameter
IP	:	Iris profile
IR	:	Iris rotation
PAS	:	Peripheral anterior synechiae
AOD	:	Angle opening distance

TIA	:	Trabecular iris angle
TISA	:	Trabecular iris space area
TICL	:	Trabecular iris contact length
C	:	Cornea
AC	:	Anterior chamber
LC	:	Lens capsule
TCPD	:	Trabecular ciliary process distance
ARA	:	Angle recess area
PCD	:	Posterior chamber depth
ACG	:	Angle closure glaucoma
OAG	:	Open angle glaucoma
TM	:	Trabecular meshwork
RPB	:	Relative pupillary block
YAG	:	Yttrium aluminum garnet
PDS	:	Pigment dispersion syndrome
CT	:	Corneal thickness
IT	:	Infiltration thickness
UHR OCT	:	Ultra High-Resolution Anterior Segment OCT
SS	:	Scleral spur
AAW	:	Angle to angle width

INTRODUCTION

Ultrasound biomicroscopy (UBM) & anterior segment optical coherence tomography (AS-OCT) are recent investigative methods which are widely used in anterior segment diseases either as diagnostic methods or to evaluate the progress rate of such diseases. One of these important & widely spread diseases, is the glaucoma especially the narrow angle type **(Radhakrishnan et al., 2005-A)**.

In comparison to ultrasound biomicroscopy (UBM), AS-OCT is more user-friendly and allows for non-contact acquisition of images with near-infrared light vs. water immersion image acquisition with sound waves. The axial resolution of the AS-OCT is 18 μ m, compared to 50 μ m for the UBM **(Huang et al., 2004 and Radhakrishnan et al., 2005-A)**.

Primary angle-closure glaucoma is a visually destructive type of glaucoma that accounts for approximately half of the worldwide blindness caused by this disease **(Foster et al., 1996 & Quigley et al., 2006)**.

The closure of the anterior chamber angle (ACA) seems to be the primary abnormality leading to intraocular pressure (IOP) increase and glaucomatous optic neuropathy **(Foster et al., 2002)**.

Slit lamp biomicroscopy is used to evaluate the anterior chamber; however, the chamber angle can only be examined with specialized lenses, the most common of these being the gonioscopic mirror. In this procedure, a gonio-lens is applied to the surface of the cornea, after administration of topical

anesthesia, and the image is magnified with the slit lamp. Gonioscopy is the standard method for clinical assessment of the anterior chamber angle. Other techniques for imaging the anterior eye segment include ultrasonography and optical coherence tomography (OCT) **(Wolffsohn & Peterson, 2006)**.

Anterior segment optical coherence tomography (AS-OCT) has been introduced as an alternative imaging modality to UBM **(Radhakrishnan et al., 2001 & Nolan et al., 2007)**.

It has a potential advantage over UBM in that, it does not require a water bath. This renders the examination process more comfortable for the patient and reduces the examination time. Image acquisition can be performed by a technician with minimal experience. Several studies have evaluated quantitative measurement of the AC angle using AS-OCT **(Nolan et al., 2007 & Dada et al, 2007-B)**.

AS-OCT is most commonly used to evaluate anterior chamber angle. Assessment on AS-OCT has many advantages over gonioscopy particularly the ability to avoid both light and compression artifacts. Clinicians can document the effects of pupil size on the anterior chamber angle by taking multiple measurements while illumination is increased and decreased **(Teichman and Ahmed , 2007)**.

OCT was similar to UBM in quantitative AC angle measurement and detection of narrow angles. In addition, it was easier to use and did not require contact with the eye. Optical coherence tomography is a promising method for screening individuals at risk for narrow angle glaucoma **(Mansouri et al.,**

2010).

In Corneal diseases, AS-OCT is very useful for assessing corneal pathologies. It can be used in diagnosis of Keratoconus, studying corneal changes after collagen cross linking, assessment of corneal opacities, in determining the exact depth of foreign body penetration or the existence of a residual defect following removal. Additionally, AS-OCT can be used to diagnose and follow up corneal infiltrate, ulcer or dellen healing, as well as to document the extent of Fuchs' dystrophy **(Shousha et al., 2010).**

In uveal assessment, Visante™ anterior segment OCT is able to differentiate between cystic and solid structures involving the iris. Iris nevus, OCT can be used to monitor the thickness, width, and distance to the angle of iris tumors with the use of computer calipers. Also tumors of ciliary body could be evaluated by AS OCT **(Radhakrishnan et al., 2005-B and Bakri et al., 2007).**

For imaging of tumors of the anterior segment of the eye, UBM offers better visualization of the posterior margin and provides overall better images for entire tumor configuration compared with AS-OCT **(Bianciotto et al., 2011).**

For pediatric population: Anterior segment imaging in the pediatric population using commercially available equipment is rewarding but can be challenging, ultrasound biomicroscopy, and anterior segment optical coherence tomography can be valuable in the documentation, diagnosis, and management of pediatric anterior segment disease **(Mireskandari et al., 2011).**

That is not to say AS-OCT is without limitations. For example, AS-OCT is unable to completely penetrate the pigmented epithelium of the iris. UBM, by contrast, is able to clearly image the ciliary body, the lens, zonules and/or cysts behind the pigmented iris. Still, AS-OCT can capture entities posterior to the pigmented epithelium of the iris, such as the crystalline lens, intraocular lens implants and phakic IOLs, through a dilated pupil. Additionally, it provides exceptional detail of structures located above the pigmented epithelium of the iris, such as the cornea and anterior chamber angle **(Lee and Ahmed , 2006)**.

AIM OF THE STUDY

To compare between optical coherence tomography (OCT) and ultrasound biomicroscopy (UBM) in assessment of the anterior segment of the eye .

Anterior Segment Optical Coherence Tomography

Optical coherence tomography (OCT), which was introduced in the 1990s, is a non contact imaging method that provides detailed cross - sectional images of biological tissues by measuring their optical reflections. OCT has been widely used clinically in ophthalmological practice for a number of years. It has been a significant advance in diagnosis and monitoring treatment of vitreoretinal diseases such as age - related macular degeneration and macular edema, as well as glaucoma **(Schaumberg et al., 2003 & Uchino et al., 2008)**.

OCT technology has evaluated the incorporation of spectral – domain (SD) imaging that offers significant advantages over the traditional time – domain (TD) OCT techniques, which include faster imaging speed, high resolution, better visualization. Simultaneously with these improvements; the utility of OCT in the ophthalmic practice has become more extended. For example, anterior segment OCT (AS-OCT), which provide high resolution cross – sectional images of anterior segment structures, including anterior chamber angle, cornea, conjunctiva, and tear film meniscus, has recently gained popularity **(Nichols et al., 2004 ,Yokoi and Komuro, 2004 & Savini et al., 2006)**.

This technology obtains in vivo cross – sectional images of tissues, but uses light waves to obtain the reflectivity profile of the structure under investigation **(Huang et al., 1991 & Van velthoven et al., 2007)**.

Anterior Segment Optical Coherence Tomography (AS-OCT) employs light instead of sound to determine tissue depth and relies on the principle that two waves of light out of phase cancel each other. It is used with the patient seated in the upright position. Anterior Segment Optical Coherence Tomography (AS-OCT) uses a 1.3 micrometer wave length super luminescent LED light, which is better suited for imaging of the anterior chamber angle due to certain reasons. At this wave length, the amount of scattering in tissue is less thereby enabling greater penetration of light through inherently scattering ocular structures such as the sclera and iris. Secondly, since water in the ocular media absorbs the 1.3 micrometer wavelength light, only 10 % of the incident light on the cornea reaches the retina. This improved retinal protection allows use of high - powered illumination, which in turn enables high – speed imaging **(Huang et al., 1991)**.

In the past one and half decades since optical coherence tomography (OCT) was invented, it has grown into the most commonly applied image technology for retinal diseases, supplanting fluorescein angiography for evaluation of many diseases and vastly expanding the ability to diagnose, evaluate, and monitor treatment of a wide range of posterior segment diseases. Recently, OCT technology has been adapted for similar imaging of the anterior segment. OCT instantly covered one pressing need, which was the ability to measure the thickness of LASIK flaps and the residual stromal bed. For the first time, surgeons could reliably determine the performance of their