Role of ultrasound biomicroscopy in diagnosing various effects of eye trauma

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By

Ahmed Rashad Mohamed
M.B., B.Ch- Zagazig University

Supervised by

Professor Dr.

Tarek M. Mahmoud Abd-Allah

Professor of Ophthalmology

Faculty of Medicine

Ain Shams University

Dr.

Azza Mohamed Ahmed Said

Lecturer of Ophthalmology

Faculty of Medicine

Ain Shams University

Faculty of Medicine
Ain Shams University
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دور الفحص ألمجهري الحيوي بالموجات فوق الصوتية في تشخيص التأثيرات المتعددة لإصابات العين

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مقدمه من

الطبيب/ احمد رشاد محمد

بكالوريوس الطب والجراحة-كلية الطب-جامعة الزقازيق

تحت إشراف

الأستاذ الدكتور

طارق محمد محمود عبد الله

أستاذ طب وجراحة العيون

كلية الطب-جامعة عين شمس

الدكتور

عزة محمد احمد سعيد

مدرس طب وجراحة العيون

كلية الطب-جامعة عين شمس

كلية الطب

جامعة عين شمس

القاهرة

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Summary

Ultrasound biomicroscopy (UBM) is a new imaging technique that uses high frequency ultrasound (50-100 MHz), providing resolution ranging from 20-60 micrometers with a depth of penetration approximately 4mm.

There are many applications to this imaging method including visualization, localization and documentation of the anterior segment anatomy and pathology.

UBM in diagnosis of trauma shows disruption of normal appearance of intra ocular structures.

UBM can be used to detect the presence of cyclodialysis and determine its extent irrespective of optic media condition, as UBM appearance of traumatic cyclodialysis is typical and diagnostic.

UBM provides clinically useful information in the detection or delineation of anterior segment foreign bodies, and it is recommended as the preferred initial imaging step in searching for an occult foreign body in the absence of an obvious rupture of the globe.

Also UBM is useful to evaluate the tomographic features of the disrupted trabecular meshwork, iridodialysis and angle recession.

UBM combined with slitlamp biomicroscopy is useful in estimating the extent of an intracorneal haematoma and corneal

بسم الله الرحمن الرحيم

وقل ربي زدني علماً

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Ahmed Rashad Mohamed

Contents

List of abbreviations

Amplitude scan	A-scan
Anterior chamber	AC
Anterior surface optical coherence tomography	OCT
Brightness scan	B-scan
Ciliary Body	CB
Contact lens	CL
Centimeter	Cm
Computerized tomography	C.T
Foreign body	F.B
Figure	Fig
Hertz	Hz
Intra-Ocular Foreign Body	IOFB
Megahertz	MHz
Millimeter	Mm
Magnetic Resonance Imaging	MRI
Micrometer	µm
Ultrasound biomicroscopy	UBM

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INTRODUCTION

Ocular trauma may cause various anterior segment pathologies resulting in visual impairment, such as hyphema, iridodialysis, and rupture of the anterior lens capsule, lens displacement, cyclodialysis, angle recession, and intraocular foreign body. A meticulous evaluation and appropriate treatment of the traumatized eye are crucial in preventing visual impairment because of ocular trauma. However, evaluation of these pathologies by clinical eye examination alone is often limited by trauma-related media opacities, hypotony, and distorted anatomy. Ultrasound biomicroscopy (UBM) allows a detailed imaging of the anterior segment up to 5 mm depth by using high-frequency (50–100 MHz) transducers ***(Pavlin, 1995).***

This noninvasive technique enables us to visualize cornea, sclera, angle structures, iris, lens, ciliary body, peripheral choroid, and anterior vitreous even in the presence of opaque media ***(Liebmann et al., 1998).***

UBM can also detect small foreign bodies of various compositions, including those missed by computed tomography (CT) or B-Scan ultrasound (US***) (Deramo et al., 1999).*** In ***2006, Sujata et al.,*** reported in their study about role of UBM in imaging anterior segment foreign bodies that the foreign bodies detection rates were 36.5% by ultrasound, 88.9% by CT scan, and 94.4% by UBM.

Therefore, UBM is a helpful tool in the evaluation of the traumatized eyes by detecting anatomic disturbances and foreign body(ies) of the anterior segment. UBM produces high-resolution axial images of the anterior globe, providing cross-sectional views of the angle in vivo similar to those of a histological section ***(O¨zdal et al., 2003).***

UBM is an effective method for identifying occult zonular damage in patients with anterior segment trauma. There is a significant learning curve in the examination technique. The ability to diagnose zonular rupture preoperatively is of significant benefit to the surgeon and might reduce the chance of intraoperative complications ***(Whea et al., 2002).***

UBM was used to determine the pathogenesis of transient high myopia after blunt eye trauma. Comparison of the refraction, anterior chamber depth, lens thickness, axial length, and the UBM-determined appearance of the choroid and ciliary body during the acute stage was performed, Transient high myopia after blunt trauma founded to be caused by anatomic changes in the ciliary body and crystalline lens. The anterior shifts of the lens-iris diaphragm caused by ciliochoroidal effusion with ciliary body edema and thickening of the crystalline lens from blunt eye trauma are involved in traumatic high myopia ***(Ikeda et al., 2002).***

UBM findings of a wider angle and absence of cyclodialysis have been reported to be significant predictors for the development of traumatic glaucoma in eyes with closed globe injury ***(Sihota et al., 2008).***

UBM found to be very useful for diagnosing, deciding therapeutic modalities and following up the clinical courses of angle-recession patients ***(Akemi et al., 2003).***

UBM examination may be clinically helpful, especially when blood prevents accurate slit lamp examination of the anterior segment. A comparative study shows that Anterior Segment OCT (AS-OCT) measurements are significantly correlated with UBM measurements but show poor agreement with each other. It was not believed that AS-OCT can replace UBM for the quantitative assessment of the anterior chamber angle ***(Netland & Singh, 2008).***

UBM can also demonstrate retained lens fragments within the posterior chamber ***(Oliveira et al., 2006).***

Aim of the study

The aim of the study was to describe the different applications of UBM and its effectiveness as recent imaging technology for diagnosing the different effects of ocular trauma.

ULTRASOUND BIOMICROSCOPY

Physics of High Frequency Ultrasound

Mechanical waves and vibrations occur over a wide range of frequencies called acoustic spectrum. Sound occupies the range from 10 Hz-20 Khz. Frequencies more than 20 KHz are the ultrasonic frequencies. From 100 KHz-1 MHz ultra sound has numerous applications, the most important of these is SONAR (sound navigation and ranging), which is the human imitation of echolocation methods of many animals ***(Langevin and Chilowski, 1916)***.

Frequencies between 3.5-5 MHz are used in body imaging application where significant penetration of tissues is needed. These frequencies have the ability to penetrate the tissues to a depth of 15-20 cm and still return signals of sufficient strength to form an image. As frequency increases, the ultrasound is more strongly attenuated, reducing penetration. Higher frequencies 7-10 MHz can be used in small parts imaging such as visualization of the eye, where penetration of 4-5 cm is sufficient.

Figure (1) shows the ultrasound is an acoustic wave that consists of oscillation of particles within a medium. Ultrasound is propagated as a longitudinal wave that consists of alternating compressions and rarefactions of molecules as the wave passes through a medium.