Recent Anterior Segment Imaging Techniques

Essay

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الوسائل الحديثة لتصوير الجزء الأمامي للعين

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Emad Hamdy Ibrahim

List of Abbreviations

3D	:	Three dimensional

3-D	:	Three dimensional
AA	:	Analyzed area
AC	:	Anterior chamber
ACIOL	:	Anterior chamber intra ocular lenses
ACP	:	Average corneal power
ALK	:	Automated lamellar keratectomy
ALK	:	Automated lamellar keratectomy
AOD	:	Angle opening distance
B & W	:	Black and white
CLAS	:	Corneal leaser analysis system
CSI	:	Center/surround index
Cyl	:	Cylinder
D	:	Diopter
D	:	Distance
DSI	:	Differential sector index
EKR	:	Equivalent K- readings
IAI	:	Irregular astigmatism index
IOL	:	Intraocular lens
IOP	:	Intra ocular pressure
KHZ	:	Kilohertz
KI	:	Keratoconus index
KPI	:	Keratoconus predictability index
LASIK	:	Laser in situ keratomileusis
MHZ	:	Megahertz
Mink	:	Minimum kertementric value
OSI	:	Opposite sector index
PAR CTS	:	Posterior apical radius corneal topography system
PAR	:	Posterior apical radius
PAR	:	Posterior apical radius
PC	:	Posterior chamber

List of Abbreviations (Cont.)

PCIOL	:	Posterior chamber intra ocular lenses
PRK	:	Photo refractive keratectomy

PRK	:	Photorefractive keratectomy
PVA	:	Potential visual acuity
QF	:	Quality factor
SAI	:	Surface asymmetry index
SDP	:	Slandered deviation of corneal power
Sim K	:	Simulated keratotomy
SRI	:	Surface regularity index
SRI	:	Surface regularity index
T	:	Time
UBM	:	Ultrasound biomicroscopy
V	:	Velocity
VHF	:	Very high frequency

List of Figures

List of Figures (Cont.)

List of Figures (Cont.)

Contents

Page

الملخص العربـــي

منذ بداية ابتداع علم طب وجراحة العيون كانت هناك دائماً حاجة إلى تطوير وسائل الفحص للأجزاء المختلفة للعين. وتناقش هذه الرسالة وسائل فحص الجزء الأمامي من العين كالماسح المقطعي للقرنية والفحص باستخدام المجهري الحيوي الفوق صوتي على التردد وكاميرا شايمفلوج.

تتطور الماسح المقطعي للقرنية تطوراً سريعاً وذلك نتيجة التقدم فى جراحات تصحيح عيوب الإبصار وهو وسيلة لقياس وتحديد شكل وسمك القرنية ويستخدم كذلك فى تشخيص أمراض القرنية كالقرنية المخروطية وتحديد الأشخاص الملائمين لعمليات تصحيح الإبصار.

المجهري الحيوي الفوق صوتي عالي التردد يوفر صوراً عالية الجودة للجزء الأمامي من العين ويستخدم فى تشخيص

وعـلاج الأمـراض المختلفـة للجـزء الأمـامي مـن العـين كالجلوكومـا والأورام والإصابات والالتهابات.

كـاميرا شـايمفلوج تسـتطيع تصـوير الجـزء الأمـامي مـن العـين بداية من سطح القرنية حتى نهاية عدسة العين.

وقـد ناقشـت الرسـالة بالتفصـيل مزايـا وعيـوب كـل طريقـة ودواعي استعمالها فى مجالات الإكلينيكية المختلفة.

Introduction

Imaging in Ophthalmology has considerably improved over the past years, but only selected techniques allow high resolution imaging of anterior segment ***(Wilkins et al., 1996)***.

From the imaging techniques of the anterior segment that provide high resolution, the ultrasound biomicoscopy (UBM), which is useful in diagnosis of a wide variety of glaucoma disorders, inflammatory diseases, anterior segment tumours and trauma ***(Woo et al., 1999)***. Nowadays, there are two instruments, which are rising in the field of ultrasound imaging. The very high frequency ultrasound (VHF) is also used in evolution of corneal changes produced by refractive surgery. The three dimensional UBM investigate the performance of accommodative intra ocular lens and study the mechanism of accommodation and presbyopia ***(Stacks et al., 2005)***.

Imaging techniques of the cornea are developing rapidly, mainly because of recent advances in refractive surgery. From these techniques the corneal topography which are a placido disc type which is made up of multiple circles projected on the corneal surface and the resultant circles are captured with video camera and digitized, orbscan which is the most common instrument in clinical practice. They measure and quantify the shape and the curvature of the corneal surfaces and are used primarily as a screening tool to evaluate prospective refractive surgery candidates and a diagnostic aid in evaluating refractive surgery patient with poor out come. ***(Peter et al., 2005)***.

Oculus pentacam is a new imaging device, that scans and measures the cornea and anterior segment of the eye, with

Scheimpflug camera that rotates around a common axis. ***(Holladay et al., 2005)***. It has a golden role in refractive surgery as it gives an idea about the anterior and posterior corneal surfaces and corneal thickness from limbus to limbus. That is useful in preoperative assessment, and postoperative for patient seeking for retreatment to determine the residual stromal tissue ***(Buebl et al., 2006)***.

Pentacam can analyze the crystalline lens density, and measure the intra ocular lens tilt and decentration, also the depth of anterior chamber in planning of ins-crowed intra ocular lens ***(Gudmundsdottir et al., 2005)***.

Pentacam has a role in management of glaucoma by follow up changes in the angle of anterior chamber in response to pharmacological or surgical intervention and image the filtration bleb after glaucoma surgery ***(Buebl et al., 2006)***.

Aim of the Work

To evaluate the various imaging techniques for investigating anterior segment diseases using ultrasound biomicroscopy, corneal topography and oculus pentacam.

Corneal Topography

Introduction

Imaging techniques of the cornea are developing rapidly, mainly because of recent advances in refractive surgery. To understand the significance of new imaging techniques the relevant principles of corneal optics are reviewed. The discussion of the most common clinical method of Placido based corneal topography emphasizes important concepts of its clinical interpretation ***(Peter et al., 2005)***.

Corneal topography is a method of measuring and quantifying the shape and the curvature of the corneal surface. Most topographers consist of a placido disc made up of multiple circles which is projected on the corneal surface. The resultant circular images are reflected and captured with a video camera and digitized ***(Joo et al., 1999).***

Corneal optics and structure:

Different concepts are used to characterize optical properties of the cornea.

- Curvature of its anterior surface is about 7.8mm and posterior surface is 6.5mm.
- The shape of the anterior and posterior surface can be expressed in micrometers as the elevation of the actual

surface relative to a chosen reference surface (e.g. sphere).

These 2 concepts can characterize the overall shape and the macro-irregularities of the corneal surface (e.g. corneal astigmatism).

- Local surface changes can be expressed in micrometers. Smoothness of the surface is optically very important, and any micro irregularities of the corneal surface can significantly degrade the image.
- Power of the cornea expressed as refraction in diopters is an optical property dependent on the shape of the surfaces and the refractive index of the surface. The average anterior and posterior corneal power is 48 diopters (D) and – 6.8D respectively. To simplify it in clinical practice or in keratometry, a substitution with one refractive surface with the resulting corneal power of 42-44 D often used.
- Thickness of the cornea is about 0.5 mm at the center and 1.1mm at the periphery. Change in the thickness can induce further changes of its shape because of biomechanical changes, such as altered elasticity of the remaining tissue.

This concept is a simplification, ignoring the fact that the refracting surface is air-tear interface, and it does not account for the oblique incidence of incoming light in the corneal periphery, ***(Holladay et al., 1997)***.