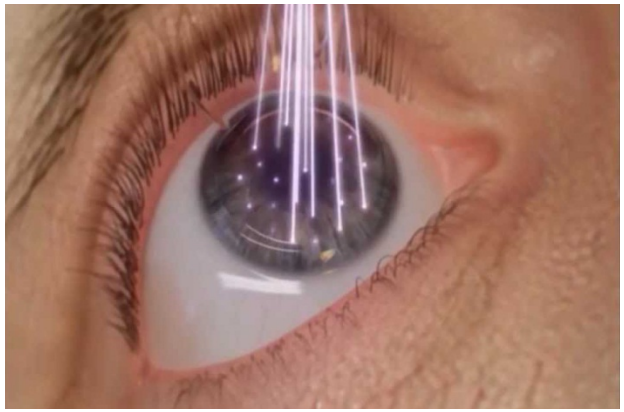

Photoablation
2020

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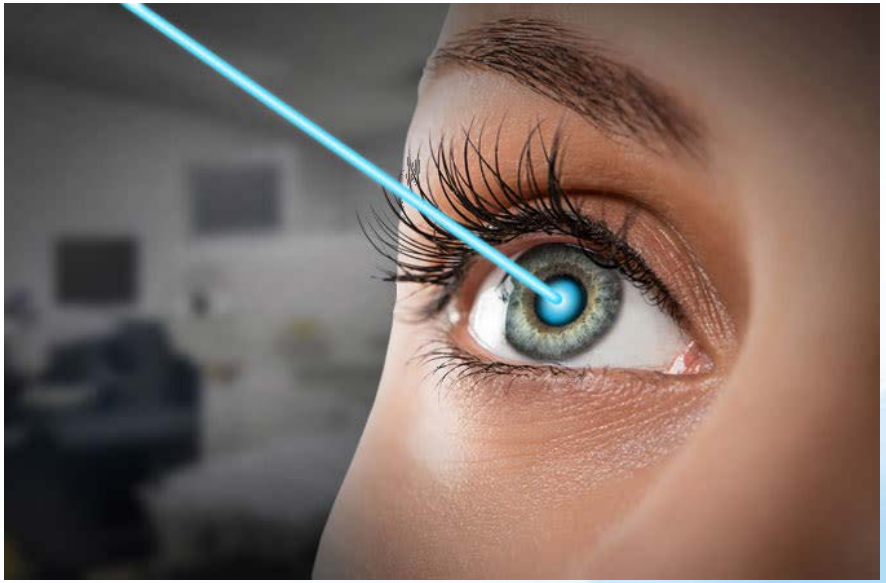
Professor Emeritus
Department of Ophthalmology
& CMU LASIK CENTER
Faculty of Medicine,
Chiang Mai University, Thailand

Photoablation Outline

- Techniques
- Outcomes
- Complications

and Adverse Effects



Photoablation Outline

- Techniques
- Outcomes
- Complications

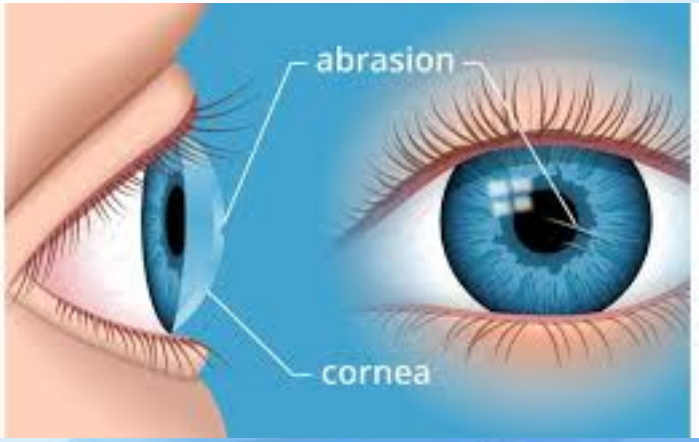
and Adverse Effects

- Surface ablation
- LASIK (Laser in Situ Keratomileusis)

Photoablation Techniques

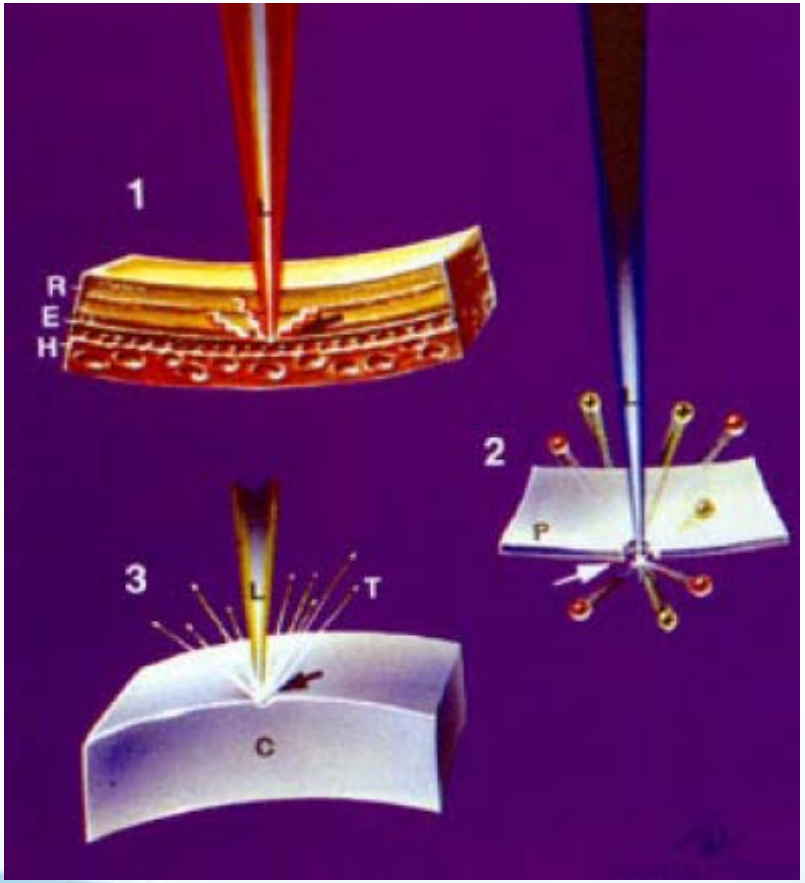
- Ablation = remove tissues (ระเหยไป)
- Photo : Excimer laser ArF 193 nm

- Abrasion (n) = การถลอก รอยขีดข่วน
- Abrade (v) = scrub ขัด



LASER in Ophthalmology

Light Amplification by Stimulated Emission of Radiation



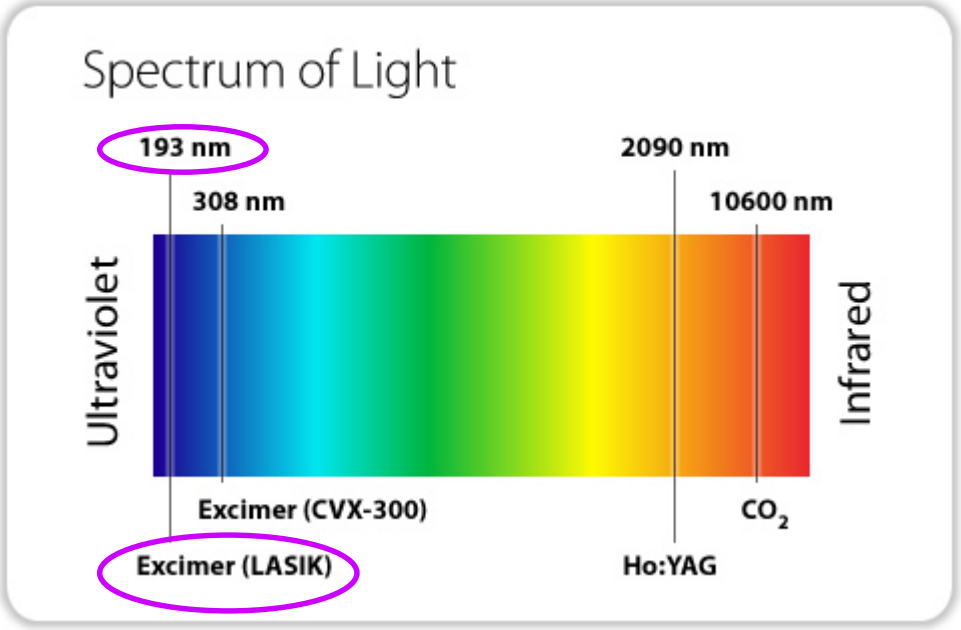
1. Argon, Krypton laser-photocoagulation
2. Nd:YAG, Femtosecond laser-photodisruption
3. Excimer laser-photoablation

LASER in Ophthalmology

Laser	Wavelength	Effects
• Excimer	193	photoablation
• Argon	488-514	photocoagulation
• Femtosecond	1053/1048	Photodisruption/ Photodissection
• Nd:YAG (Neodymium-doped yttrium aluminum garnet)	1064	Photodisruption
• CO_2	10600	photothermal

Excimer lasers

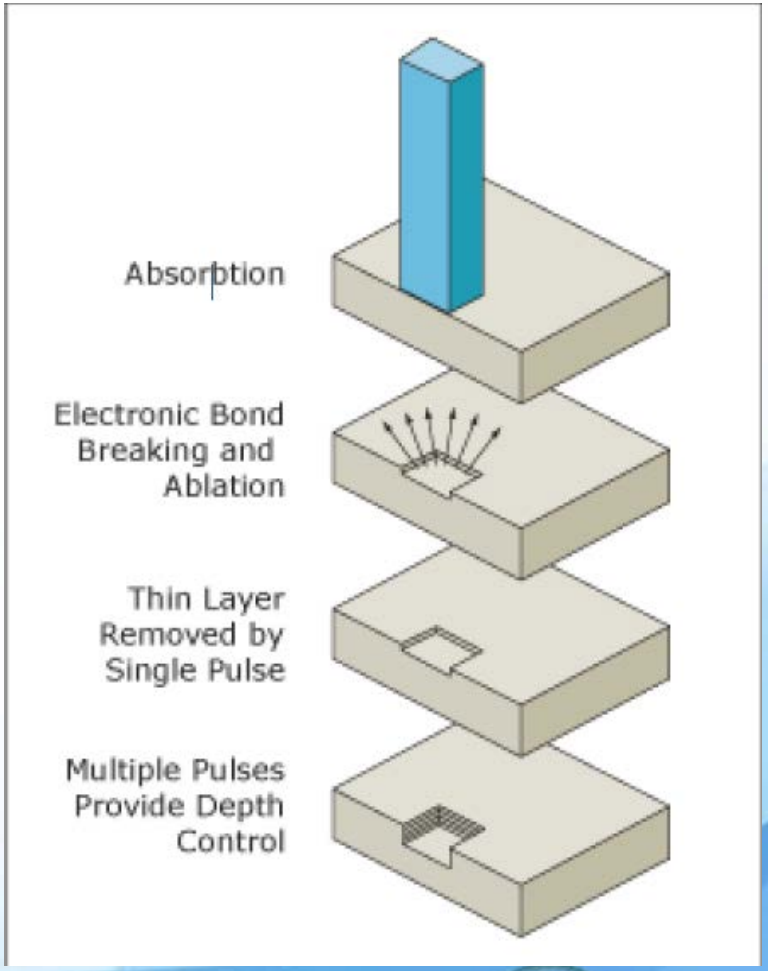
- Derived from excited + dimer (2 atoms)
- Gas lasers: noble (Ar, Kr, Xe) + reactive (Fl, Cl)
- Emit pulses of light in UV spectrum
- Most commonly used excimer lasers
  - ArF, 193 nm
  - KrF, 248 nm
  - XeCl, 308 nm



Photoablation Techniques

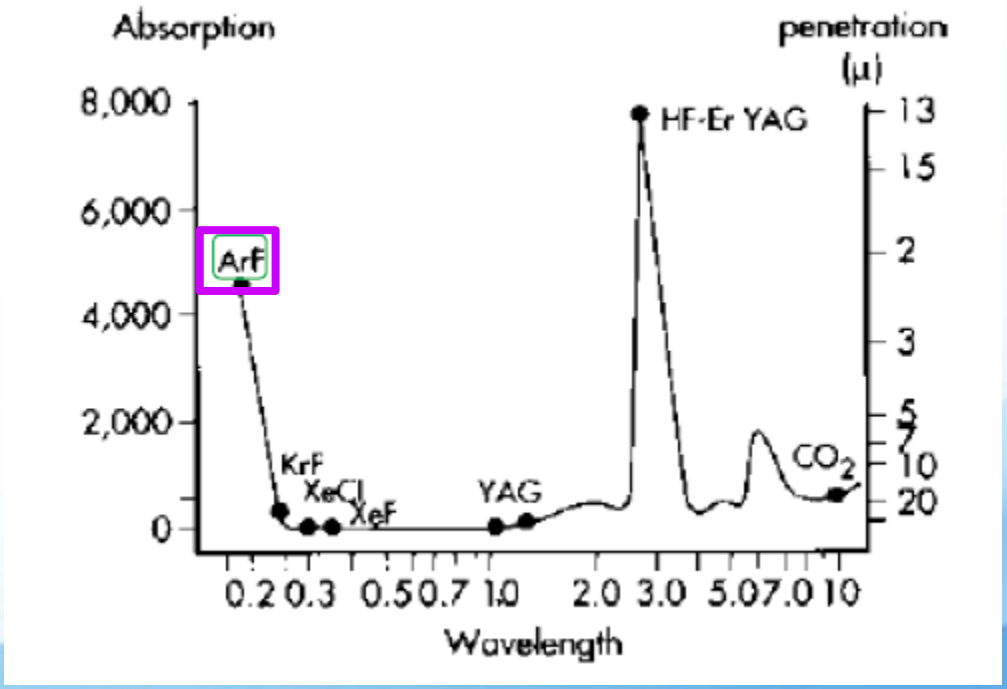
Excimer laser Mechanisms

- Rupture of intermolecular bindings
- Vaporization of corneal tissue
- No thermal damage

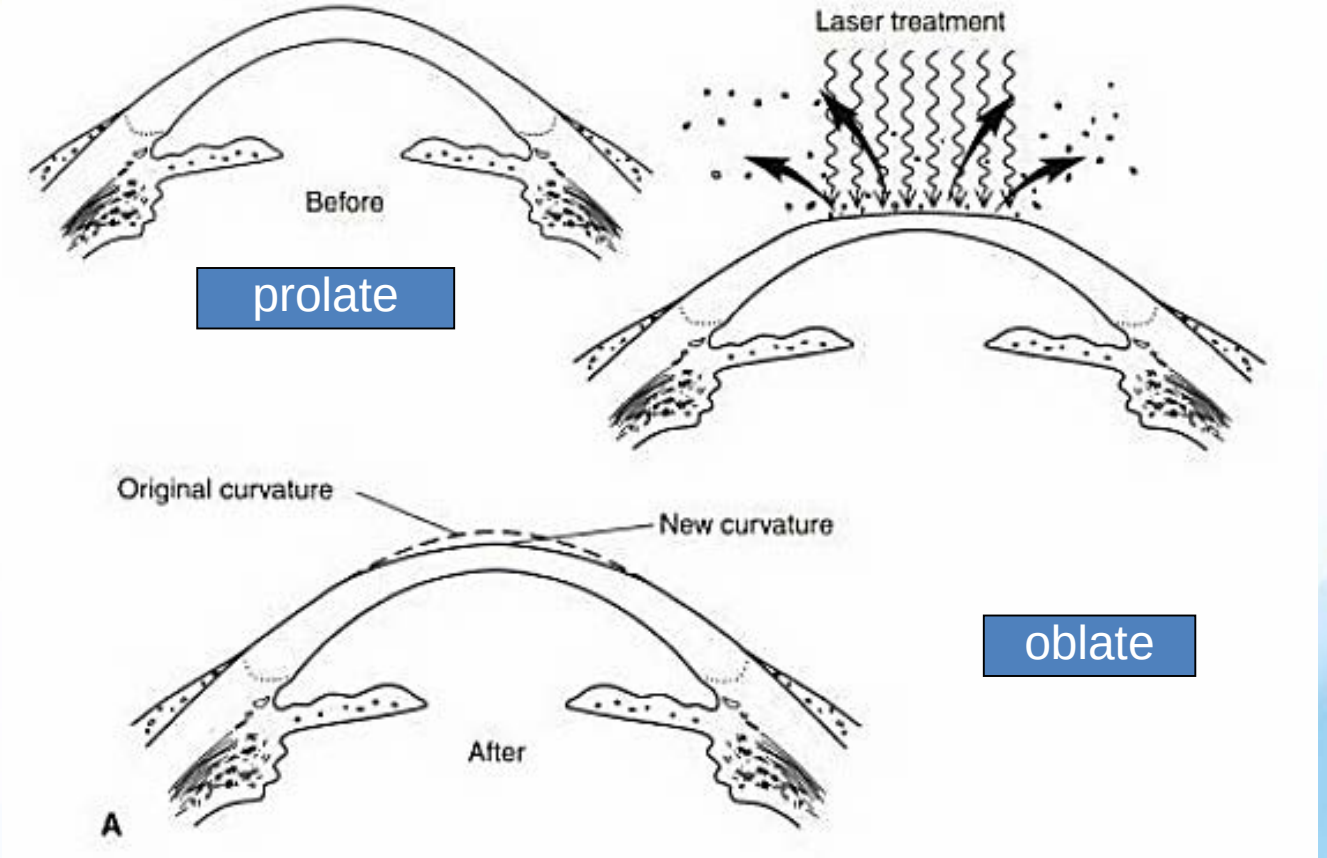


Ar F Excimer Laser in LASIK

- High absorption, low penetration in corneal surface
- Precise tissue removal with minimal damage surround tissue



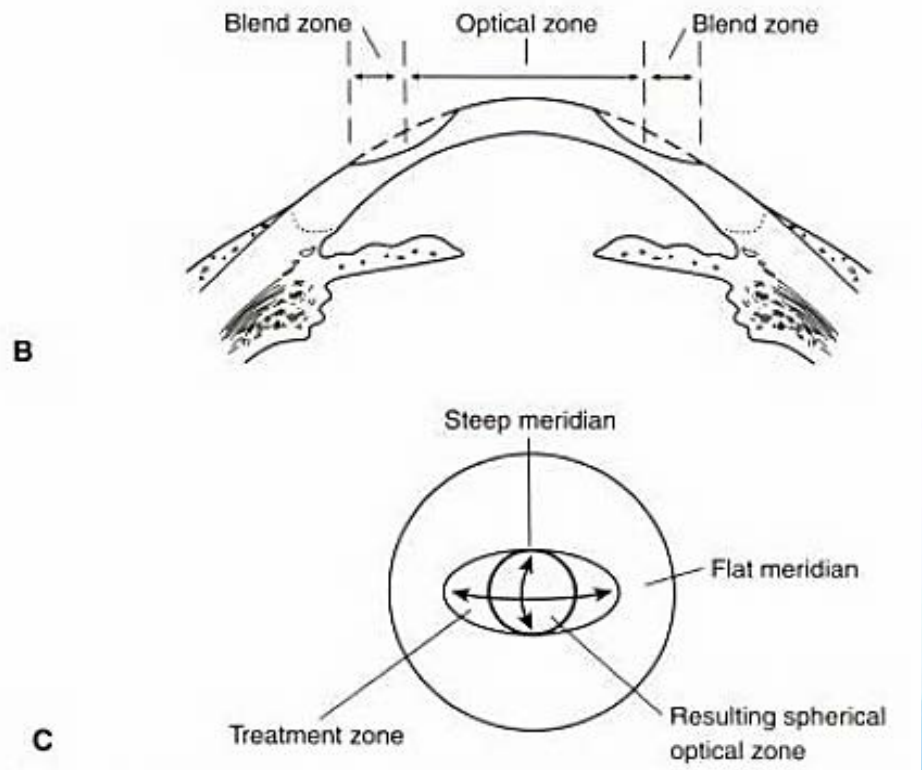
Corneal recontouring by excimer laser



Correction of **Myopia**

BCSC, Refractive surgery

Corneal recontouring by excimer laser



Correction of **Hyperopia & Astigmatism**

BCSC, Refractive surgery

Photoablation Techniques

1. Surface ablation
2. LASIK (Laser in Situ Keratomileusis)

Photoablation Techniques

1. Surface ablation
2. LASIK (Laser in Situ Keratomileusis)

Surface Ablation

- Photorefractive Keratectomy (PRK)
- Laser Subepithelial Keratomileusis (LASEK)
- Epithelial Laser in Situ Keratomileusis (Epi-LASIK)

Surface Ablation

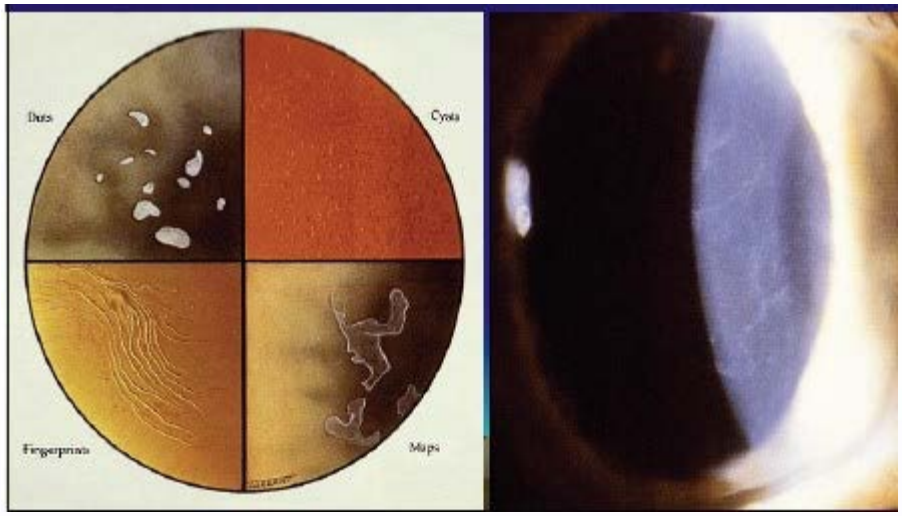
Patient Selection

- Recommendation :

- Narrow palpebral fissure
- Deep-set globe
- Thin cornea
- Epithelium basement membrane dystrophy (EBMD)

Surface Ablation
Patient Selection

- Why?



Krachmer J, et al. Krachmer: Cornea (2010) Mosby

- Recommendation :

- Flap distortion
- Delayed healing
- Epithelial ingrowth
- Flap keratolysis
- Corneal scarring

- Epithelium basement membrane dystrophy (EBMD)

Poor candidate for LASIK!!!!

Surface Ablation Techniques

- PRK – Epithelial debridement
- LASEK
- Epi-LASIK

→ Epithelial preservation

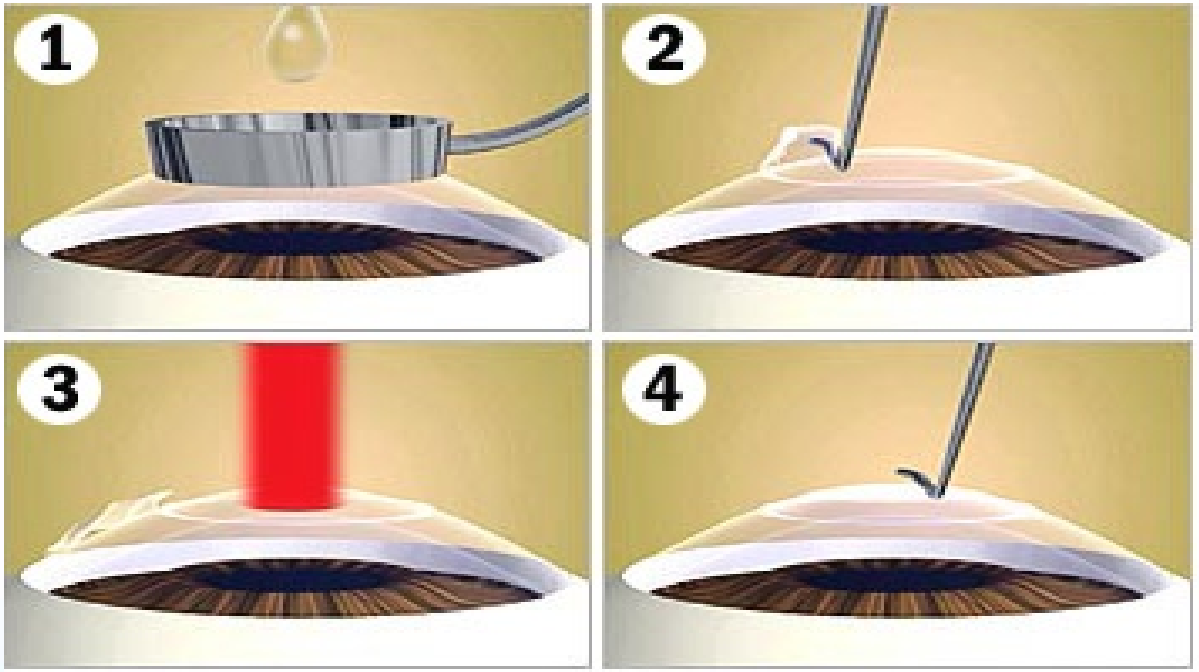
Surface Ablation Techniques

- PRK – Epithelial debridement
- LASEK
- Epi-LASIK

→ Epithelial preservation

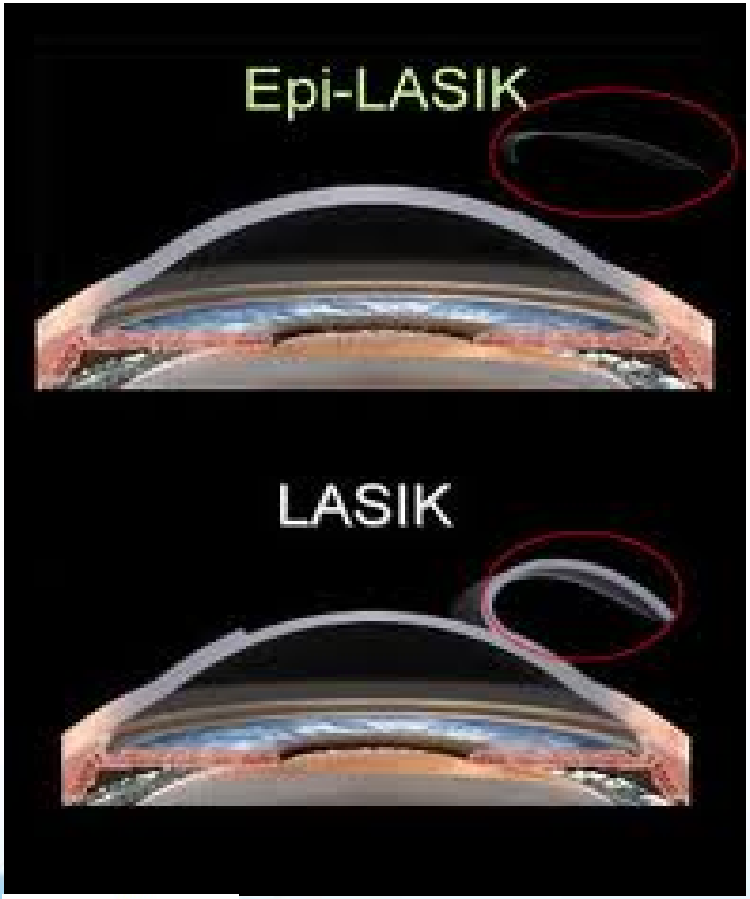
Laser Subepithelial Keratomileusis (LASEK)

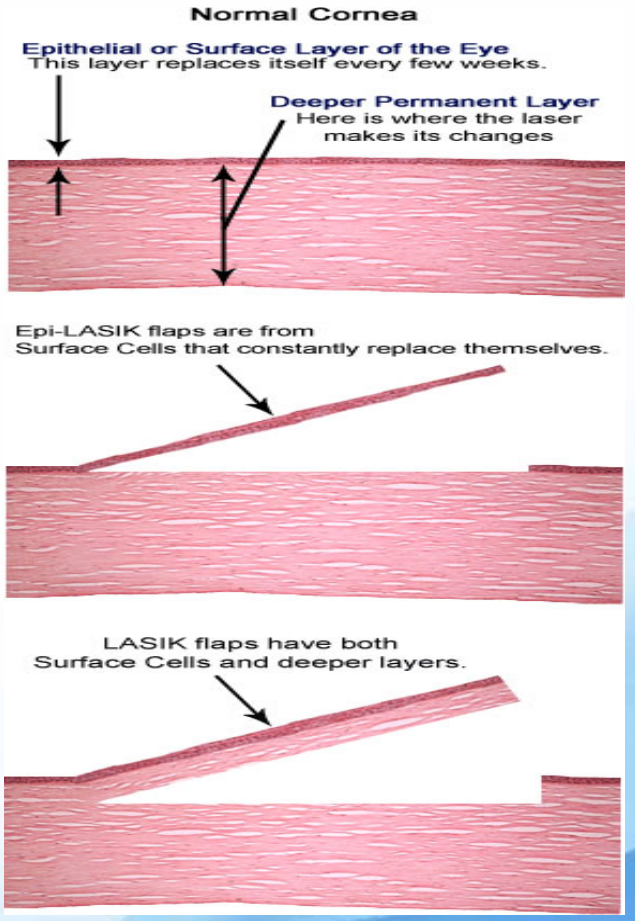
- 20% absolute alcohol



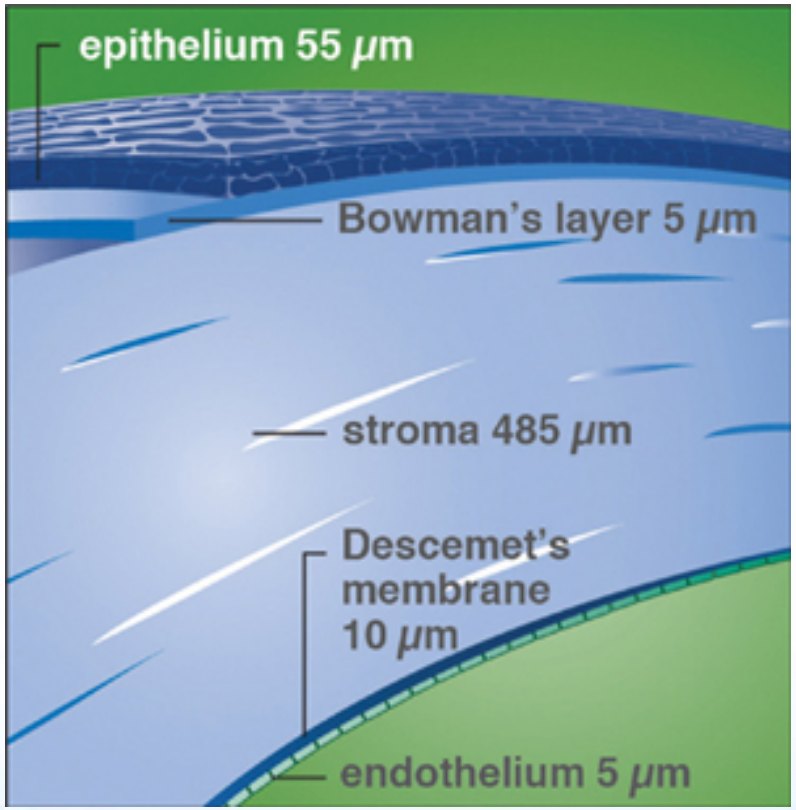
American Academy of Ophthalmology;
UCLA Laser Refractive Center at the Jules Stein Eye Institute

Epithelial Laser in Situ Keratomileusis (Epi-LASIK)





Epi-LASIK



Epi-LASIK blade 50 micron

Surface Ablation Techniques

- PRK – Epithelial debridement
- LASEK
- Epi-LASIK

→ Epithelial preservation

Surface Ablation Techniques

- PRK – Epithelial debridement

Photorefractive Keratectomy (PRK)

Epithelium debridement:

Manual:

- Mechanical : Blunt spatula, hockey blade*, wedge cell sponge, Amoils brush, diamond blur
- Chemical: 20 % absolute alcohol

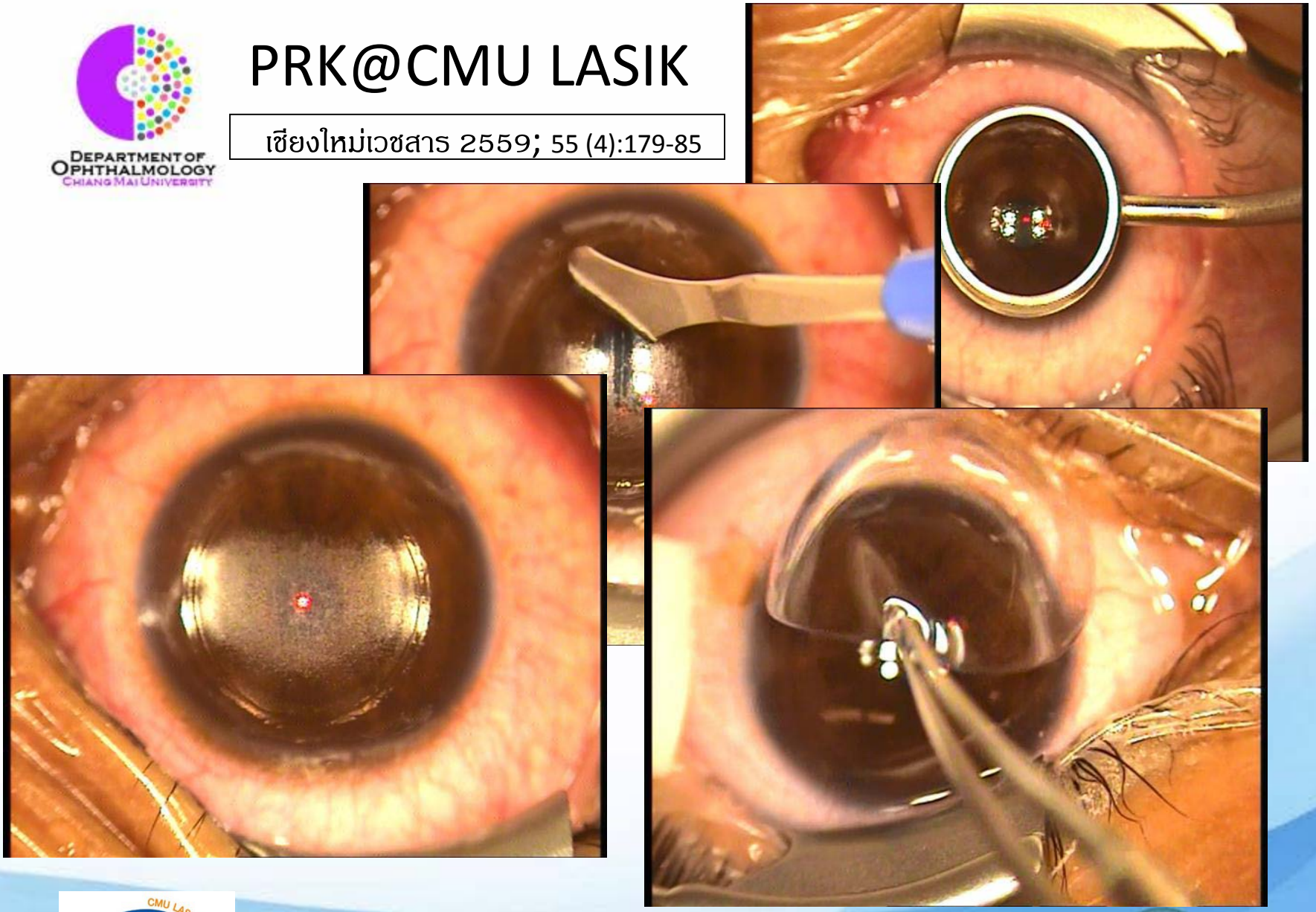
LASER:

- Excimer laser: trans-epithelium PRK*

*@ CMU LASIK CENTER

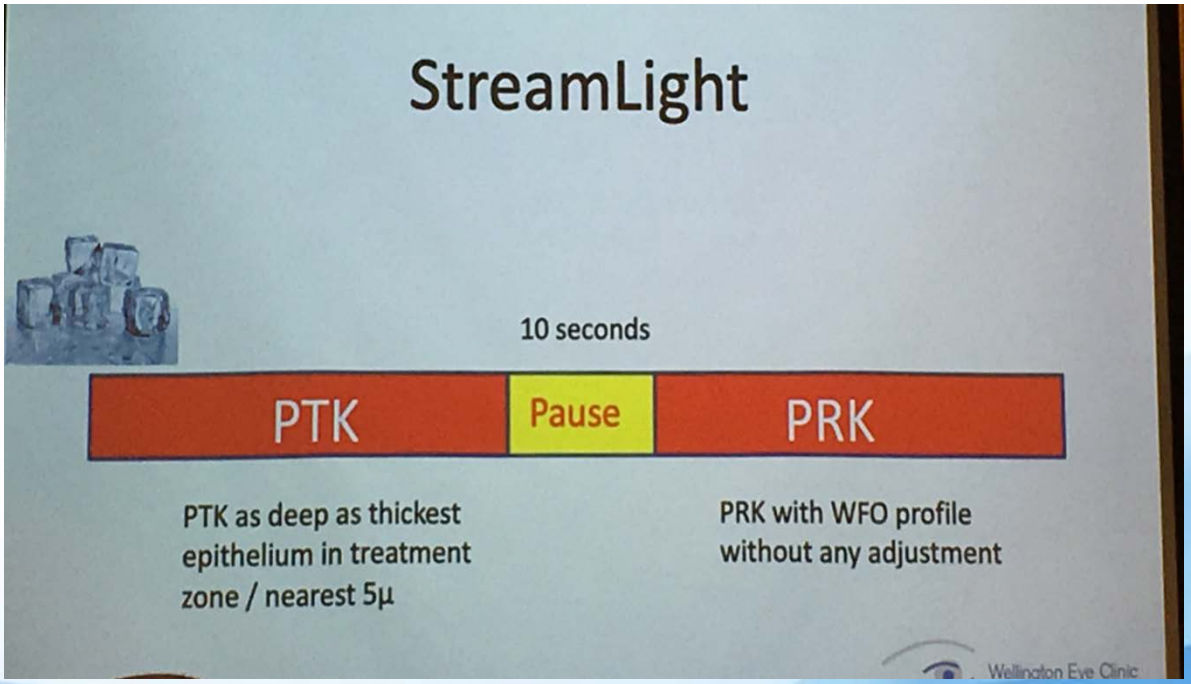
PRK@CMU LASIK

เชียงใหม่เวชสาร 2559; 55 (4):179-85



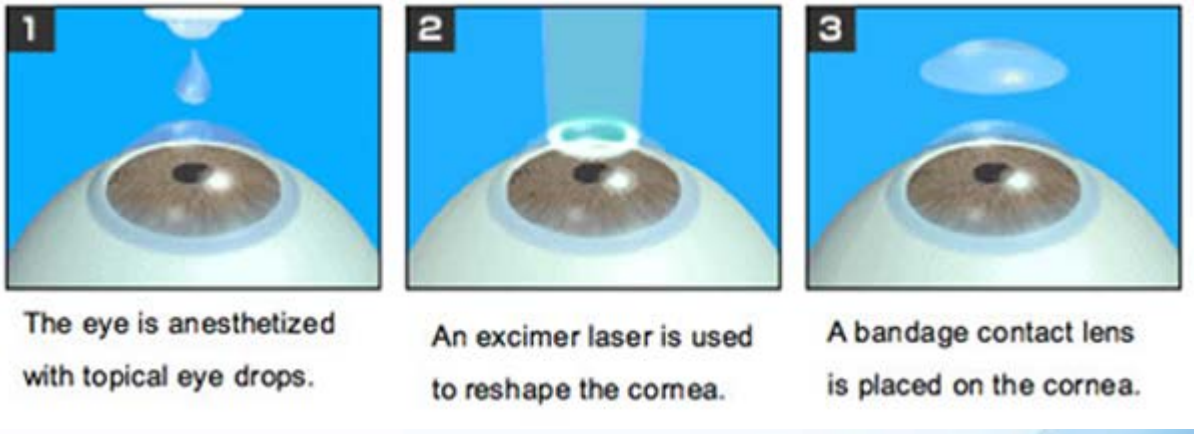
StreamLight

- One-Step Trans-epi PRK by WaveLight EX 500
- No touch, no cut technique



PRK vs PTK

- PRK = Photorefractive Keratectomy
- PTK = Phototherapeutic Keratectomy



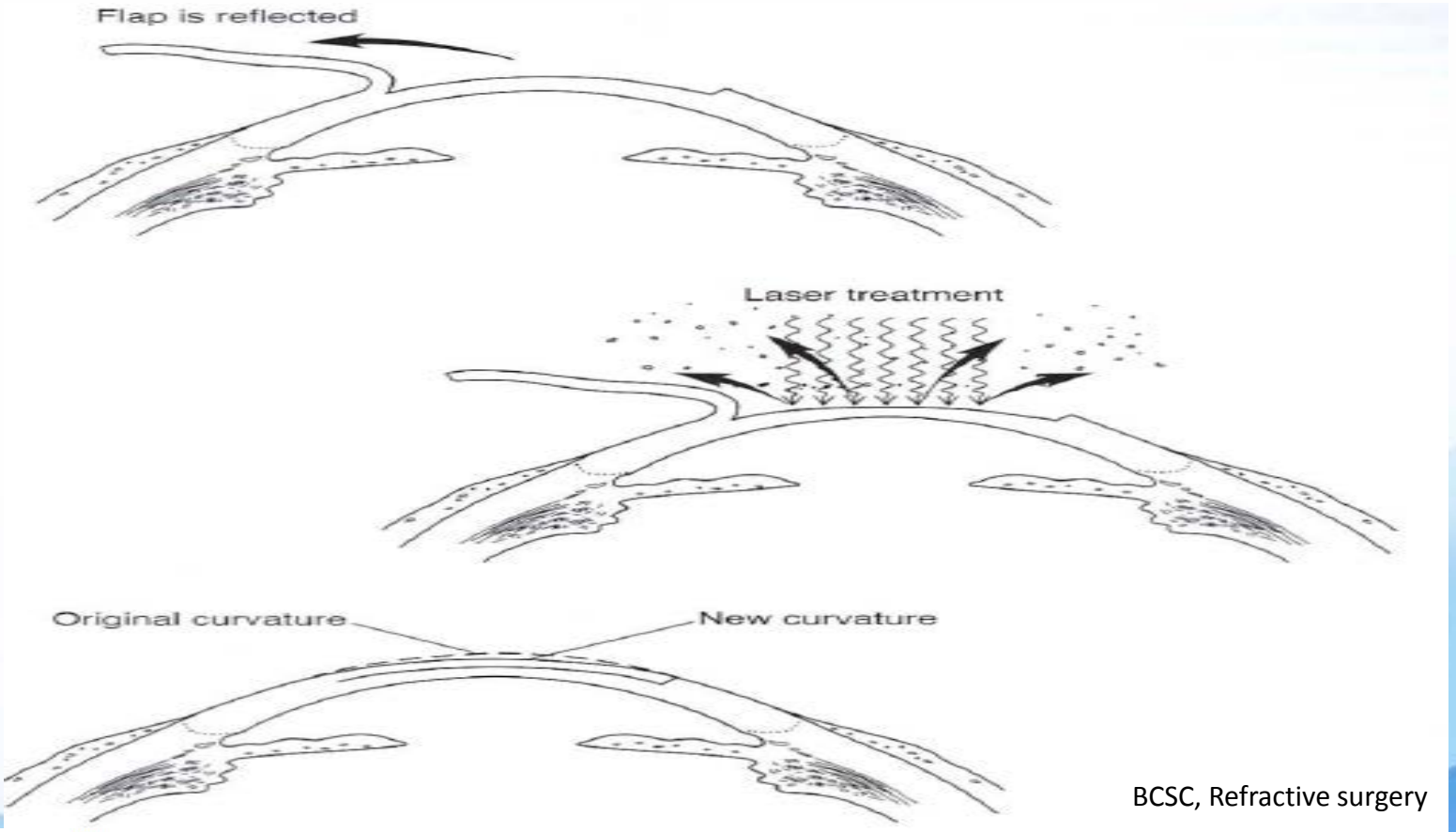
Photoablation Techniques

1. Surface ablation
2. LASIK (Laser in Situ Keratomileusis)

LASIK
(Laser in Situ Keratomileusis)

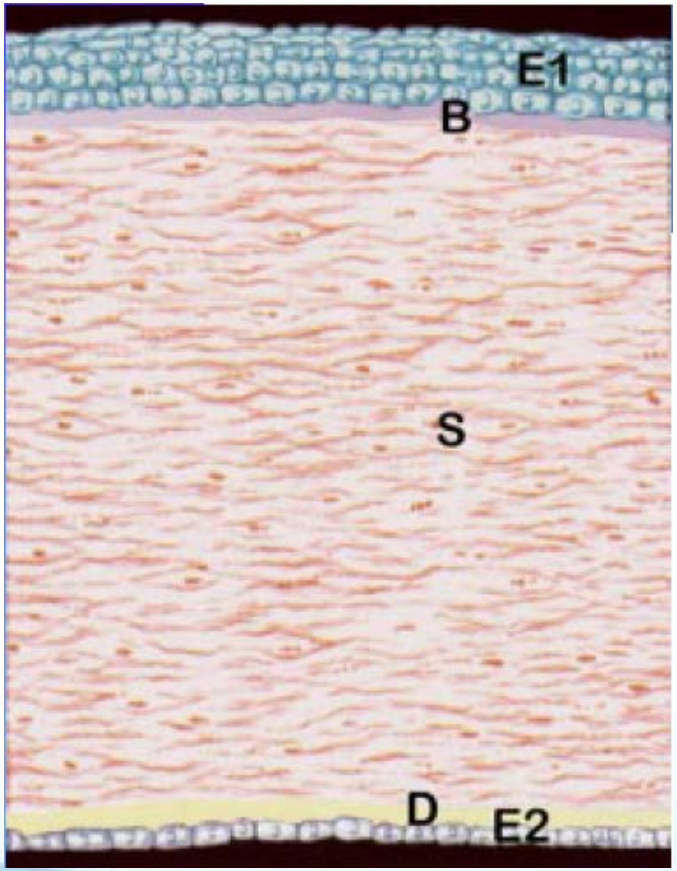
- Keratomileusis (Gr)
  - Kerato = cornea
  - Mileusis = to carve
- Laser in Situ = excimer laser stromal ablation

LASIK
(Laser in Situ Keratomileusis)



BCSC, Refractive surgery

Anatomy of Cornea



E1 Epithelium 30-50 u

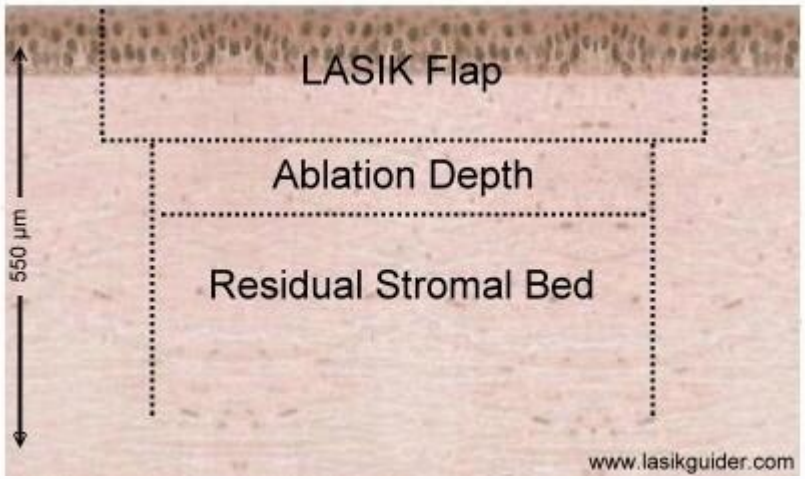
B Bowman's 10-14 u

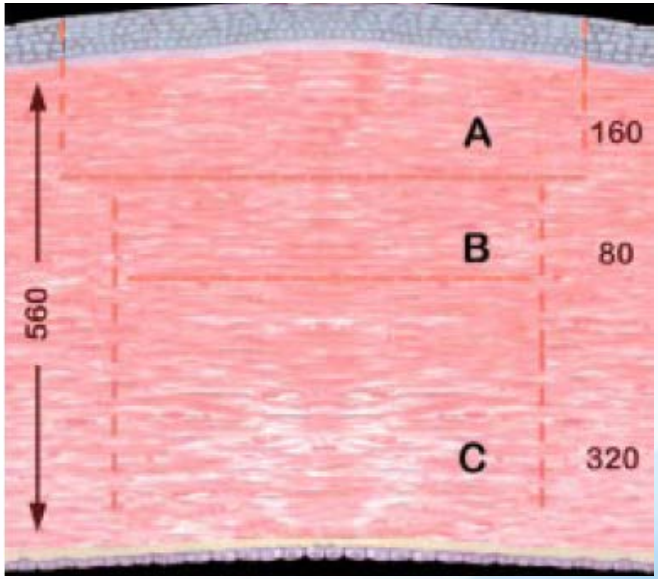
S Stroma central 500-550 u

D Descemet's 3-12 u

E 2 Endothelium 4-6 u

Cornea Tissue Ablation





US FDA : Residual stromal bed > 250 u or 50% corneal thickness

CMU LASIK Center : Residual stromal bed > 300 u

Residual stromal bed = CCT-A-B = 560-160-80 = 320 u

Residual stromal bed: MK-LASIK<FS-LASIK<PRK

Surface Ablation vs LASIK

Advantages	Disadvantages
For Epithelial basement membrane dystrophy (EBMD)	Pain, PO discomfort ↑
For Thin cornea	Cornea haze ↑
No flap complications	Infectious keratitis ↑
Dry eyes ↓	Visual recovery ↓

Surface Ablation vs LASIK

บทความฟื้นวิชา

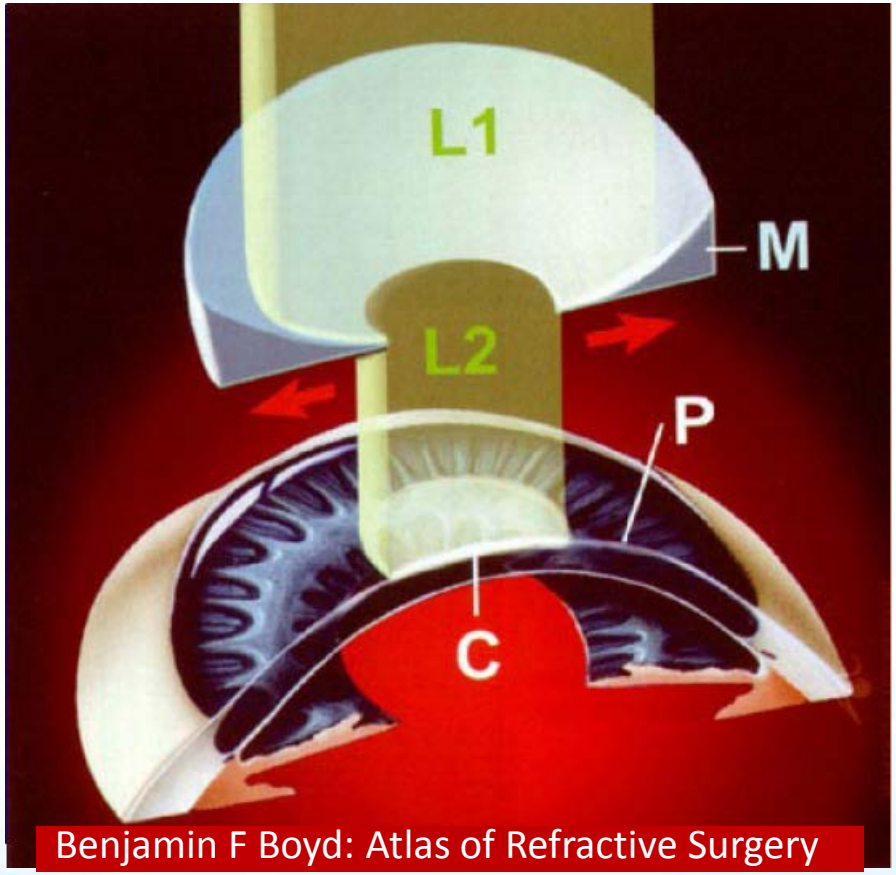
Photorefractive keratectomy อีกทางเลือกสำหรับการผ่าตัดแก้ไขสายตาผิดปกติ

สมสงวน อัษญคุณ และ สุเมธ สุพละเศรษฐ์

ภาควิชาจักษุวิทยา คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่

พีอาร์เค เป็นการผ่าตัดแก้ไขสายตาผิดปกติ โดยการลอกหรือขูดเยื่อบุผิวกระจกตา แล้วใช้ excimer laser ปรับแต่งความโค้งของกระจกตา โดยไม่ต้องมีการแยกชั้นกระจกตาแบบเลสิค บทความนี้กล่าวถึง ข้อดี และข้อด้อยของพีอาร์เค เมื่อเปรียบเทียบกับเลสิคและการเตรียมตัวเพื่อผ่าตัดโดยพีอาร์เค **เชียงใหม่เวชสาร** 2559;55(4):179-85.

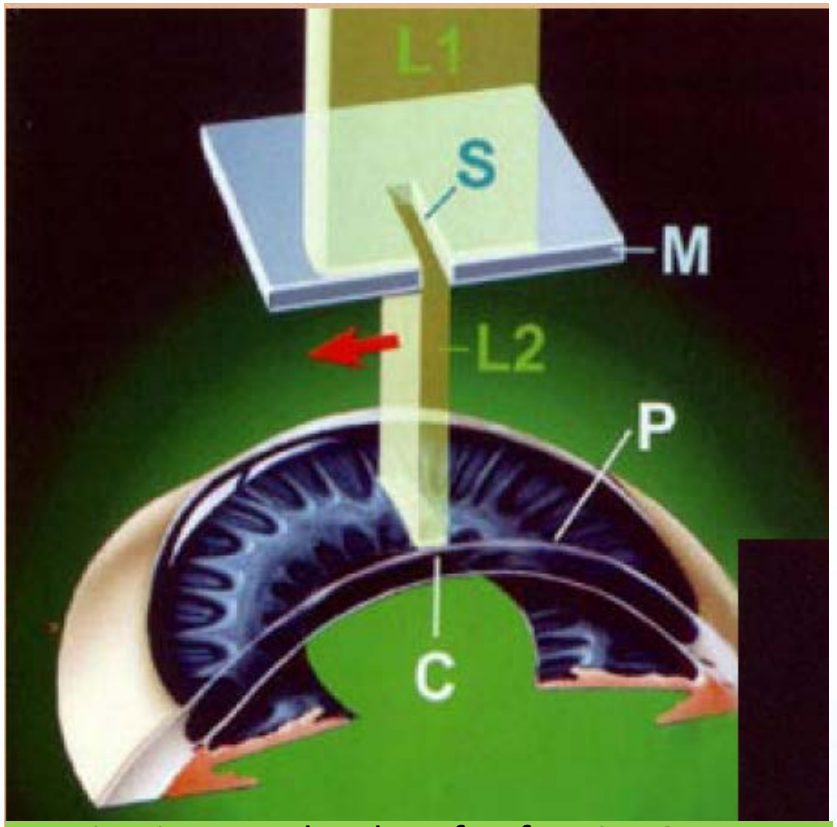
Evolution
Excimer Laser in LASIK



Benjamin F Boyd: Atlas of Refractive Surgery

Broad beam laser

Evolution
Excimer Laser in LASIK



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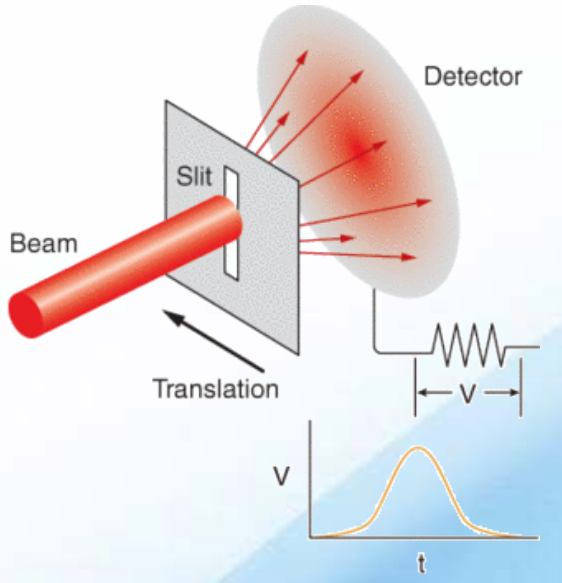
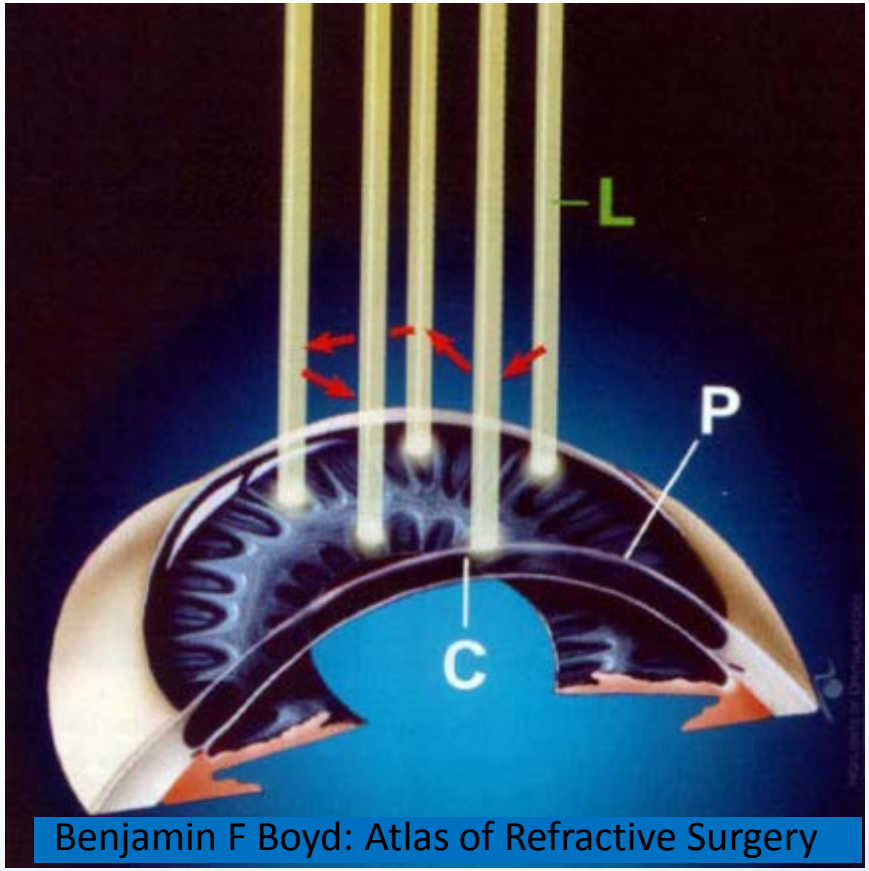


Slit scanning laser

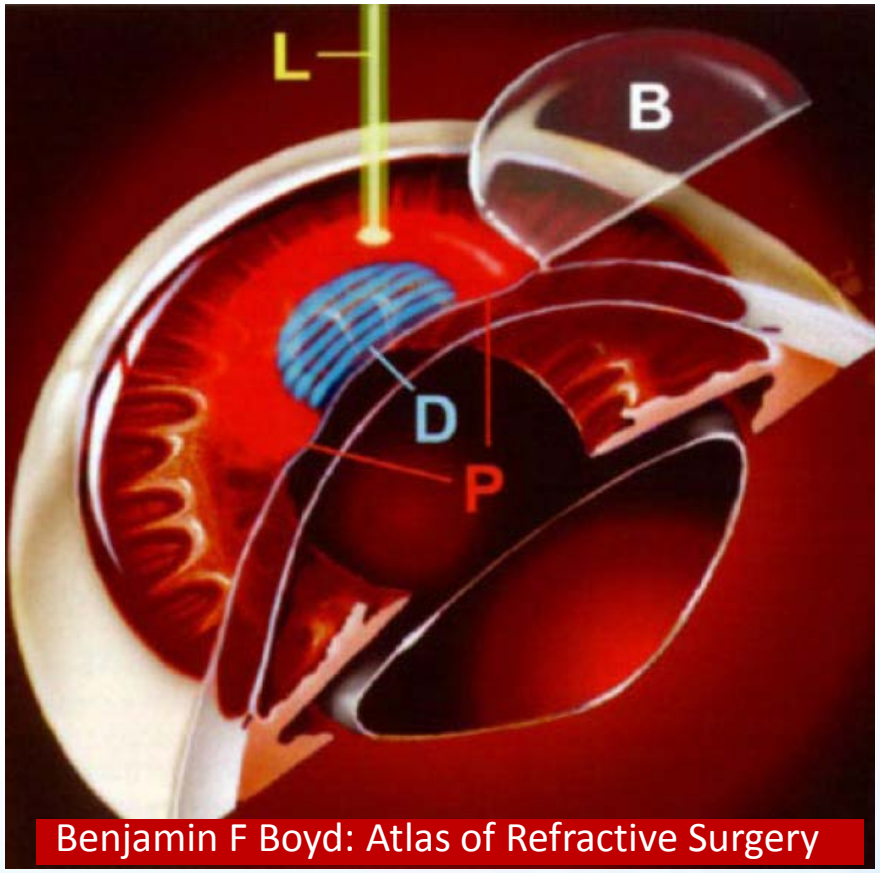
Evolution
Excimer Laser in LASIK



Benjamin F Boyd: Atlas of Refractive Surgery

Flying spot laser

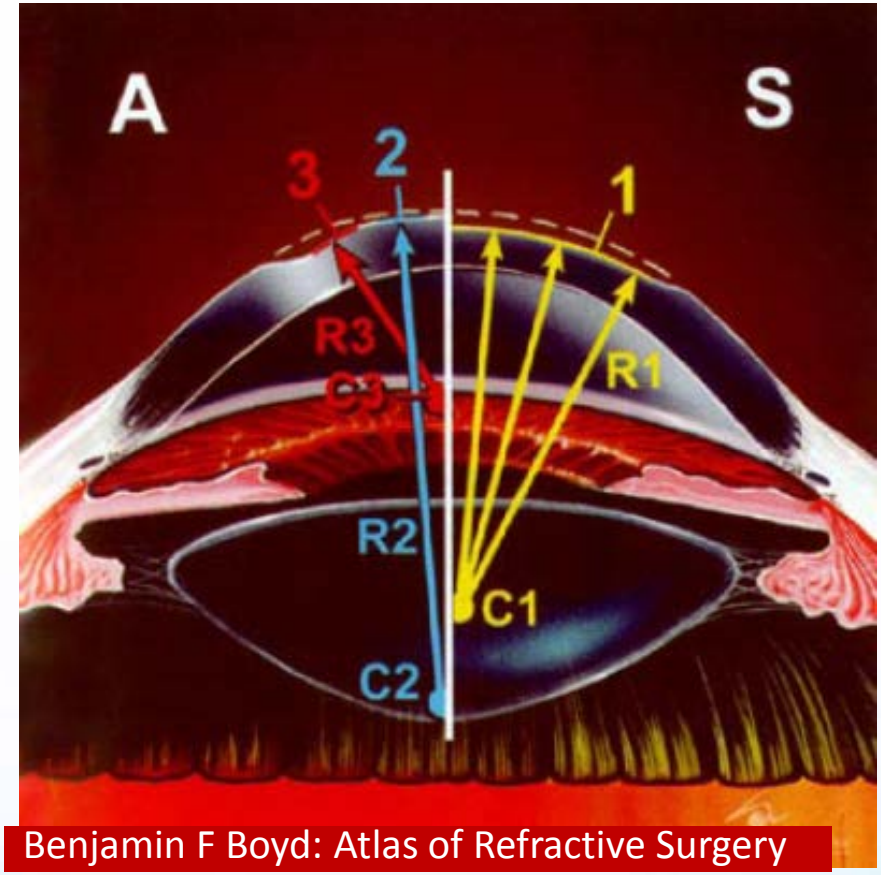
Evolution
Excimer Laser in LASIK



Benjamin F Boyd: Atlas of Refractive Surgery

Flying spot laser &
Customized ablation

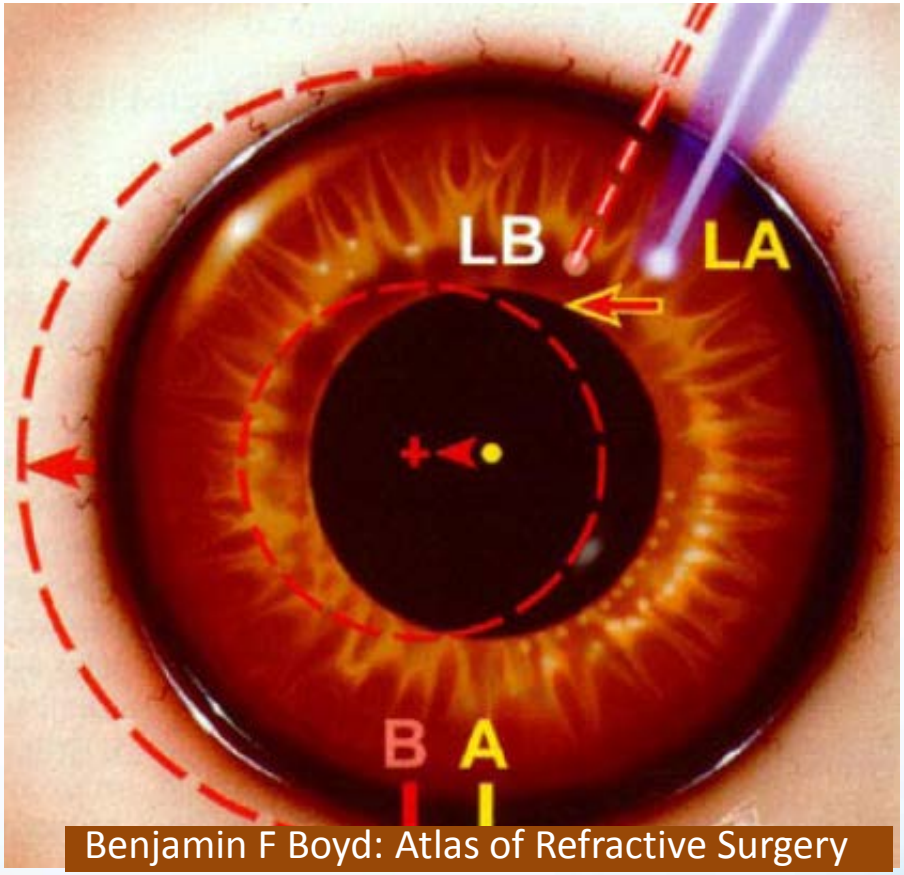
Evolution
Excimer Laser in LASIK



Benjamin F Boyd: Atlas of Refractive Surgery

Flying spot laser
& Aspherical ablation

Evolution
Excimer Laser in LASIK

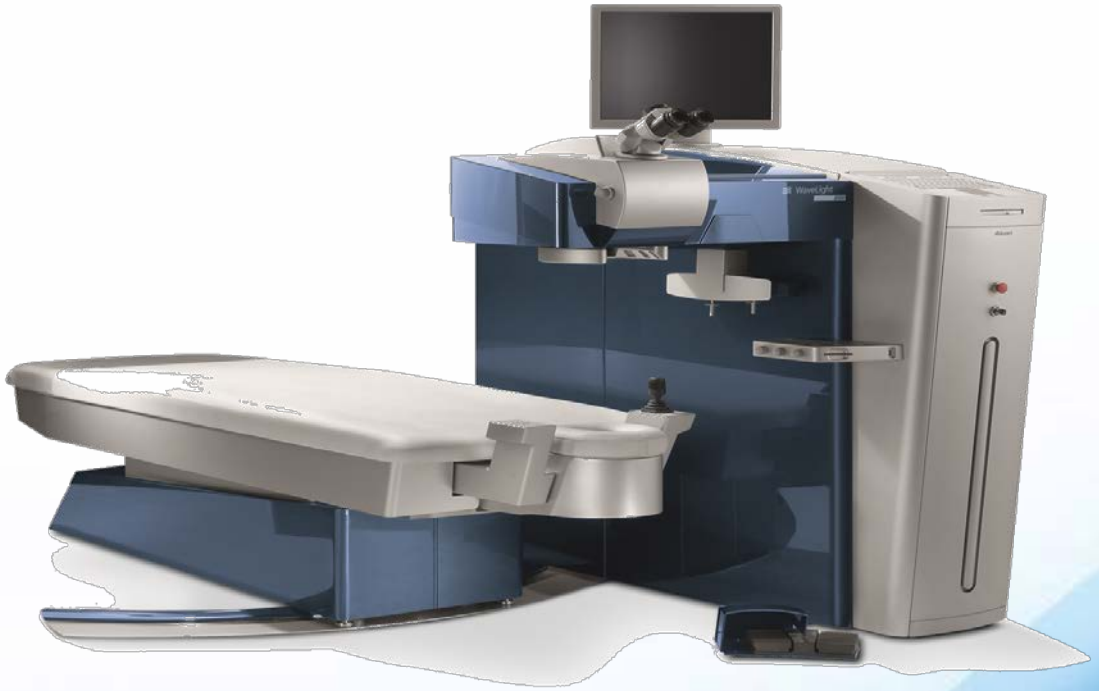


Benjamin F Boyd: Atlas of Refractive Surgery

Eye tracking system
& Iris registration

CMU LASIK CENTER

WaveLight EX500 (Excimer Laser)

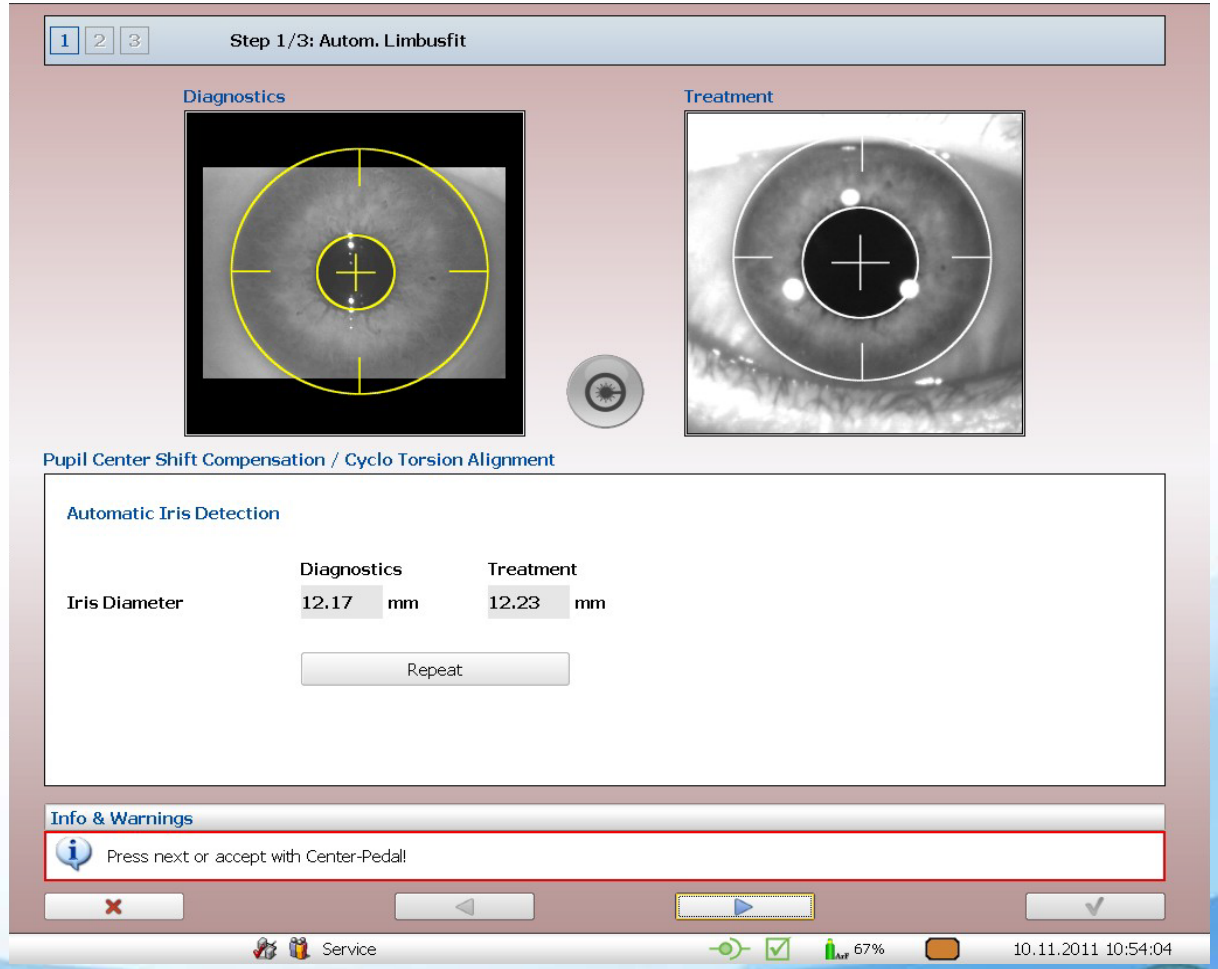


WaveLight EX500 (Excimer Laser)

- Pulse rate 500 Hz, Treatment rate of 1.4 sec per diopter myopia, Gaussian beam profile, Flying Spot laser beam
- Eye tracker rate 1050 Hz monitoring eye movements every 2 milliseconds
- On-board nitrogen generator to ensure laser purity and consistent fluency
- Integrated network ability with femtosecond and diagnostic equipment
- Cyclotorsion alignment and pupil center compensation

WaveLight EX500

CycloTorsion Alignment (CTA) & Pupil Center Shift Compensation (PCSC) Mode



WaveLight EX500 Treatment capabilities

	WaveLight customized treatment capabilities				
Indication*	Wavefront Optimized™	Custom Q®	Wavefront-guided (ALLEGRO Analyzer)	Topography-guided (ALLEGRO Topolyzer)	Topography-guided (ALLEGRO Oculyzer)
Myopia	-14 D	-14 D	-12 D	-14 D	-14 D
Hyperopia	+6 D	+6 D	+6 D	+6 D	+6 D
Astigmatism	-6 D to +6 D	-6 D to +6 D	-3 D to +3 D	-6 D to +6 D	-6 D to +6 D
Mixed astigmatism	6 D	6 D	3 D	6 D	6 D
Presbyopia	•	•			
Enhancements	•	•	•	•	•
Ocular aberrations			•		
Corneal irregularities			•	•	•
Small optical zones		•	•	•	•
Decentrations			•	•	•
Suboptimal corneal asphericity		•		•	•

*Possible treatment range depends on corneal thickness and optical zone size.
atment range can differ from country to country.

Component of Vision

- Neural component
- Optical component

a. Focusing factor

b. Scattering factor

c. Absorption factor

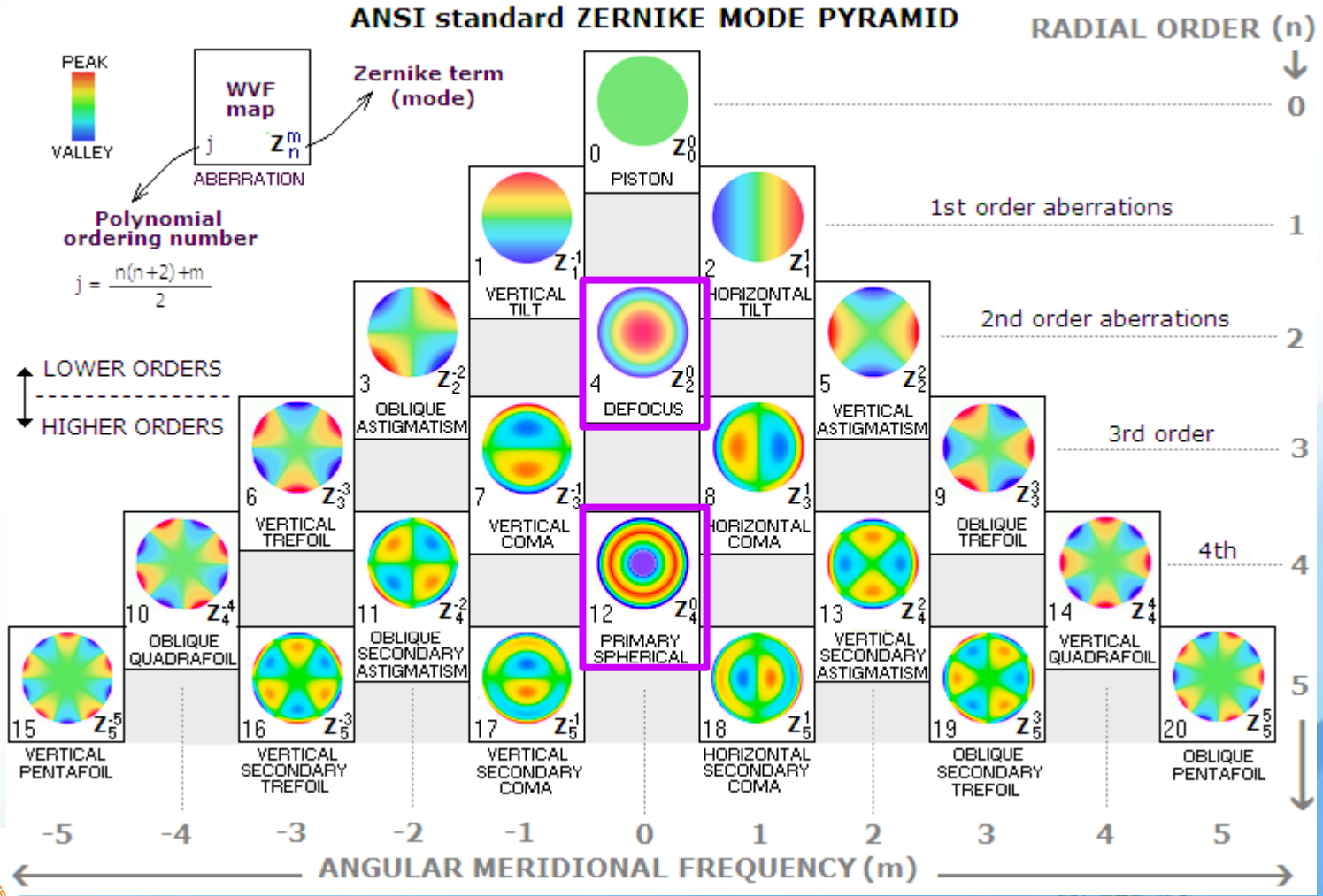
d. Diffraction factor

e. Aberration factor

Aberration of light

- Frits Zernike was a Dutch physicist
- Nobel Prize for physics in 1953 for his invention of the phase-contrast microscope

Zernike Pyramid

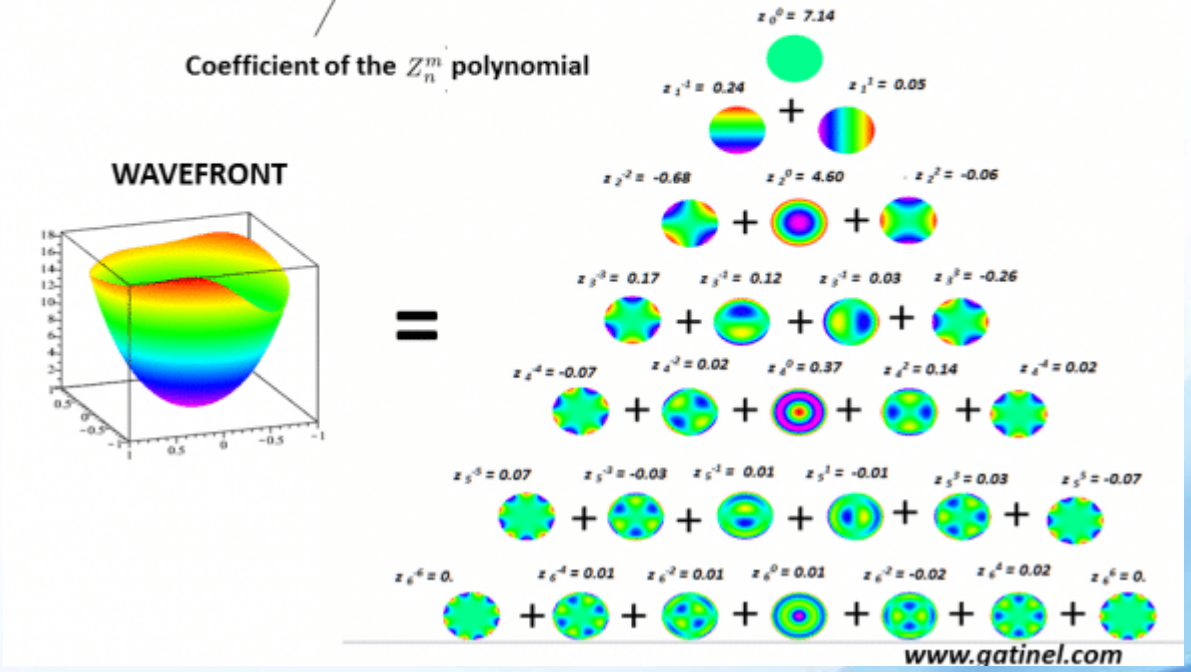


Zernike Polynomials

WAVEFRONT ERROR DECOMPOSITION INTO ZERNIKE POLYNOMIALS

$$f = \sum_{n \in \mathbb{N}} \left(\sum_{m \in I_n} z_n^m(f)\, Z_n^m \right) = \sum_{m \in \mathbb{Z}} \left(\sum_{n \in J_m} z_n^m(f)\, Z_n^m \right)$$

Coefficient of the Z_n^m polynomial



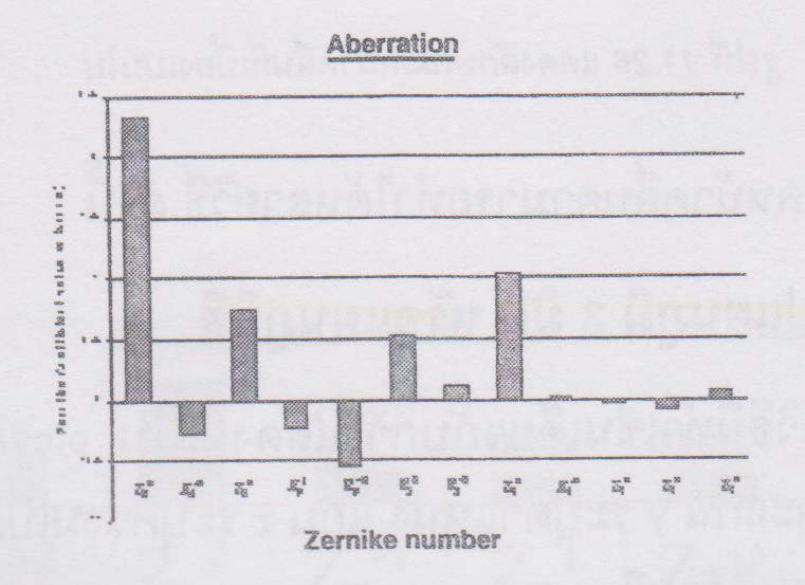
Zernike Equations

$z0 = 1;$	Piston or Bias
$z1 = \rho \cos[\theta];$	Tilt x
$z2 = \rho \sin[\theta];$	Tilt y
$z3 = -1 + 2\rho^2;$	Power
$z4 = \rho^2 \cos[2\theta];$	Astig x
$z5 = \rho^2 \sin[2\theta];$	Astig y
$z6 = \rho\,(-2 + 3\rho^2) \cos[\theta];$	Coma x
$z7 = \rho\,(-2 + 3\rho^2) \sin[\theta];$	Coma y
$z8 = 1 - 6\rho^2 + 6\rho^4;$	Primary Spherical
$z9 = \rho^3 \cos[3\theta];$	Trefoil x
$z10 = \rho^3 \sin[3\theta];$	Trefoil y
$z11 = \rho^2\,(-3 + 4\rho^2) \cos[2\theta];$	Secondary Astigmatism x
$z12 = \rho^2\,(-3 + 4\rho^2) \sin[2\theta];$	Secondary Astigmatism y
$z13 = \rho\,(3 - 12\rho^2 + 10\rho^4) \cos[\theta];$	Secondary Coma x
$z14 = \rho\,(3 - 12\rho^2 + 10\rho^4) \sin[\theta];$	Secondary Coma y
$z15 = -1 + 12\rho^2 - 30\rho^4 + 20\rho^6;$	Secondary Spherical
$z16 = \rho^4 \cos[4\theta];$	Tetrafoil x
$z17 = \rho^4 \sin[4\theta];$	Tetrafoil y
$z18 = \rho^3\,(-4 + 5\rho^2) \cos[3\theta];$	Secondary Trefoil x
$z19 = \rho^3\,(-4 + 5\rho^2) \sin[3\theta];$	Secondary Trefoil y
$z20 = \rho^2\,(6 - 20\rho^2 + 15\rho^4) \cos[2\theta];$	Tertiary Astigmatism x
$z21 = \rho^2\,(6 - 20\rho^2 + 15\rho^4) \sin[2\theta];$	Tertiary Astigmatism y
$z22 = \rho\,(-4 + 30\rho^2 - 60\rho^4 + 35\rho^6) \cos[\theta];$	Tertiary Coma x
$z23 = \rho\,(-4 + 30\rho^2 - 60\rho^4 + 35\rho^6) \sin[\theta];$	Tertiary Coma y
$z24 = 1 - 20\rho^2 + 90\rho^4 - 140\rho^6 + 70\rho^8;$	Tertiary Spherical
$z25 = \rho^5 \cos[5\theta];$	Pentafoil x
$z26 = \rho^5 \sin[5\theta];$	Pentafoil y
$z27 = \rho^4\,(-5 + 6\rho^2) \cos[4\theta];$	Secondary Tetrafoil x
$z28 = \rho^4\,(-5 + 6\rho^2) \sin[4\theta];$	Secondary Tetrafoil y
$z29 = \rho^3\,(10 - 30\rho^2 + 21\rho^4) \cos[3\theta];$	Tertiary Trefoil x
$z30 = \rho^3\,(10 - 30\rho^2 + 21\rho^4) \sin[3\theta];$	Tertiary Trefoil y
$z31 = \rho^2\,(-10 + 60\rho^2 - 105\rho^4 + 56\rho^6) \cos[2\theta];$	Quatenary Astigmatism x
$z32 = \rho^2\,(-10 + 60\rho^2 - 105\rho^4 + 56\rho^6) \sin[2\theta];$	Quatenary Astigmatism y
$z33 = \rho\,(5 - 60\rho^2 + 210\rho^4 - 280\rho^6 + 126\rho^8) \cos[\theta];$	Quatenary Coma x
$z34 = \rho\,(5 - 60\rho^2 + 210\rho^4 - 280\rho^6 + 126\rho^8) \sin[\theta];$	Quatenary Coma y
$z35 = -1 + 30\rho^2 - 210\rho^4 + 560\rho^6 - 630\rho^8 + 252\rho^{10};$	Quaternary Spherical

Zernike coefficient value

- Aberration magnitude

RMS < + 0.30 u @ pupil 6.0 mm



Root Mean square(RMS) = Sum of coefficient value

$$\sqrt{\frac{(\text{Coefficient Value 1})^2 + (\text{Coefficient Value 2})^2 + (\text{Coefficient Value 3})^2}{n}}$$

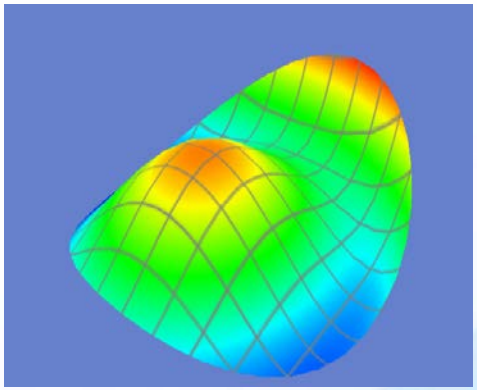
LASIK Evolution

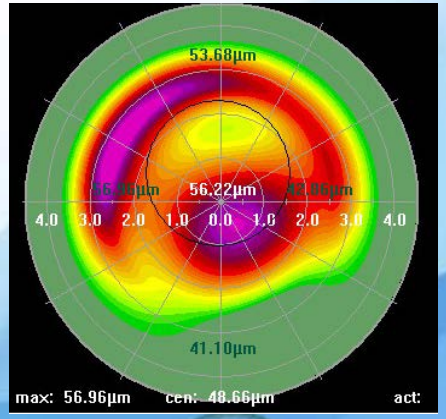
Conventional LASIK: induction of higher-order aberrations (HOAs) → glare, halos, starbursts,

reduced contrast sensitivity

Efforts to overcome the side effects

- Wavefront-optimized (WFO) ablation
  - Aspherical ablation
- Wavefront-guided (WFG) ablation
  - Ocular wavefront ablation
- Topography-guided (TG) ablation
  - Corneal wavefront ablation



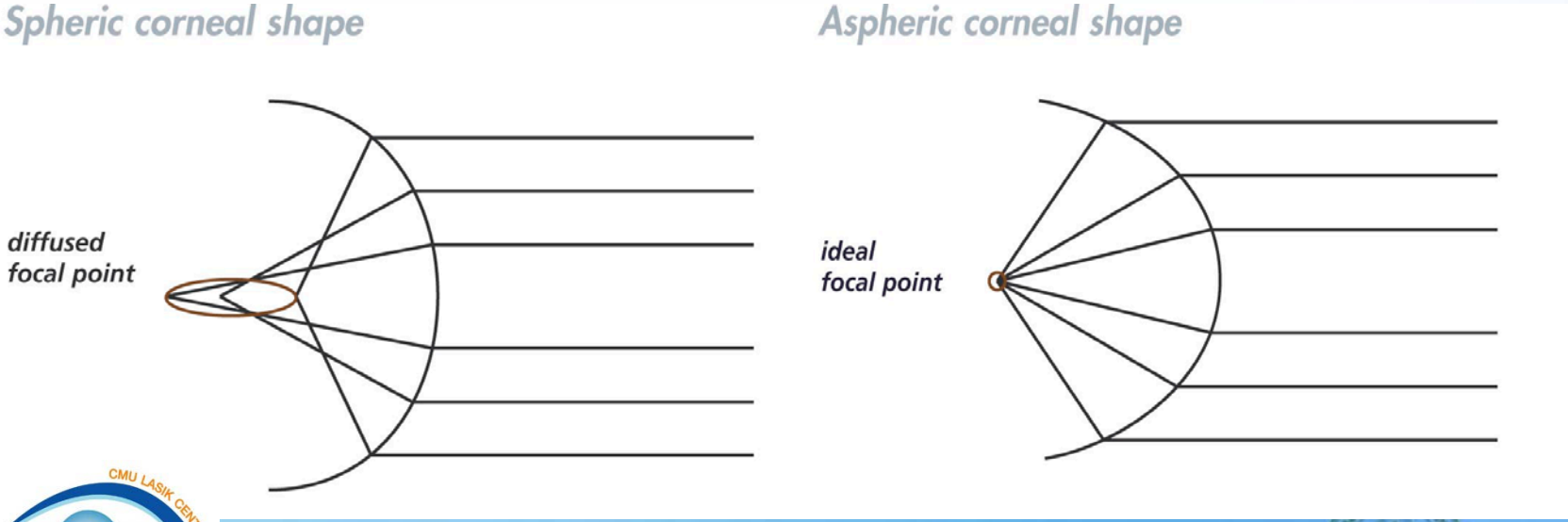


WaveLight EX 500 Ablation Profile

- Wavefront Optimized (WFO)
- Wavefront-guided (WFG)
- Topography-guided (TG)
- Custom Q

Wavefront Optimized Ablation

- Wavefront Optimized ® treatment corrects a patient's refractive error with less affect on the natural aspheric properties of the cornea
- Adding more prolate peripheral ablation



Wavefront optimized Ablation

- WFO based on
  - Keratometry & Refraction of the patient
  - Take into account the asphericity of the cornea
  - Reduce spherical aberration
  - No effect on other HOAs

Wavefront optimized Ablation

WaveLight EX 500-WFO ablation techniques:

- แก้ตามค่าสายตาที่ทำการตั้งค่า
- ปรับ Sphere และ Cylinder step 0.5
- ไม่สามารถปรับ transition zone
- Sequentially ablation: sphere then cylinder

Wavefront-Guided Ablation

- Reduce pre-existing higher order aberrations, treat all HOAs
- RMS pre-op > 0.4 u
- Time consuming
- Large amount of cornea
- Not for after cataract surgery, irregular cornea, small pupil

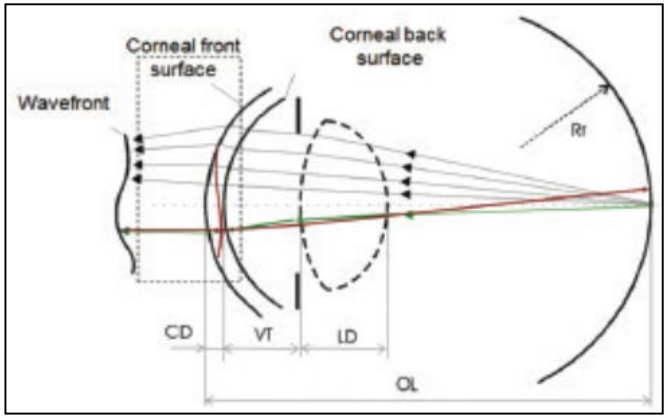
Wavefront-Guided Ablation

WaveLight EX500 -WFG ablation techniques:

- Use wavefront guide from analyzer, ภาพถ่ายอย่างน้อย 4 ครั้ง และได้ reproducibility HOA ที่ดี
- เปรียบเทียบ manifest vs analyser measure at 4.0 mm
- Keep pupil size เท่ากับค่าที่ถ่ายได้จาก analyzer
- Centering laser จะถูกตั้งตาม line of sight ไม่สามารถเลือกได้

Topography-Guided Ablation

- The difficulty is that the human wavefront aberration is dynamic & constantly changing as with accommodation.



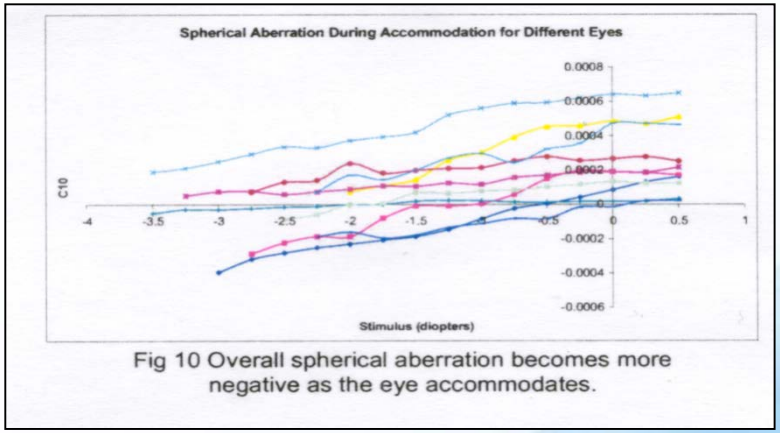


Fig 10 Overall spherical aberration becomes more negative as the eye accommodates.

- Topo-guided ablations aim to target the aberration at the anterior surface of the cornea, which is relatively constant regardless of accommodation

WaveLight EX500

Contoura® Vision Topo-guided LASIK

Topgraphy-guided ablation: Treat corneal HOA centered at corneal vertex, reduce corneal HOA

What is Contoura® Vision Topo-guided LASIK?

- **Contoura® Vision:** Name given to performing TG LASIK in virgin eyes by WaveLight EX 500
- Takes data from ALLEGRO Topolyzer or Oculyzer to create ablation profiles
  - Takes elevation data > Zernike polynomials (Documents the aberrations on the cornea)
  - The polynomials are converted to ablation profiles to remove the higher order aberrations
  - Executes the ablation profile through the Wavelight EX500

WaveLight EX500

Contoura® Vision Topo-guided LASIK

TOPOGRAPHY-GUIDED LASIK PIVOTAL STUDY – RESULTS

Contoura® Vision patients experience improvements on many of the visual symptoms commonly associated with glasses and contact lenses.[1]

Post-op symptoms at 12 months[2]

Light sensitivity	**5.2% decrease**
Difficulty driving at night	**8.0% decrease**
Reading difficulty	**8.7% decrease**
Complaints of glare	**4.8% decrease**
Halos	**3.2% decrease**
Starbursts	**2.8% decrease**

Improved symptoms typically associated with LASIK[2]

[2] *Stulting RD, Fant BS; T-CAT Study Group.* Results of topography-guided laser in situ keratomileusis custom ablation treatment with a refractive excimer laser. J Cataract Refract Surg. 2016;42(1):11-18.

Alcon a Novartis company | Contoura® Vision FDA Astigmatism Review | US-WVL-17-E-1058 | © 2017 Novartis 4/17 | WaveLight® Refractive Portfolio | Advancing Refractive Surgery

Clinical Ophthalmology

Dovepress
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Open Access Full Text Article

ORIGINAL RESEARCH

Topography-modified refraction (TMR): adjustment of treated cylinder amount and axis to the topography versus standard clinical refraction in myopic topography-guided LASIK

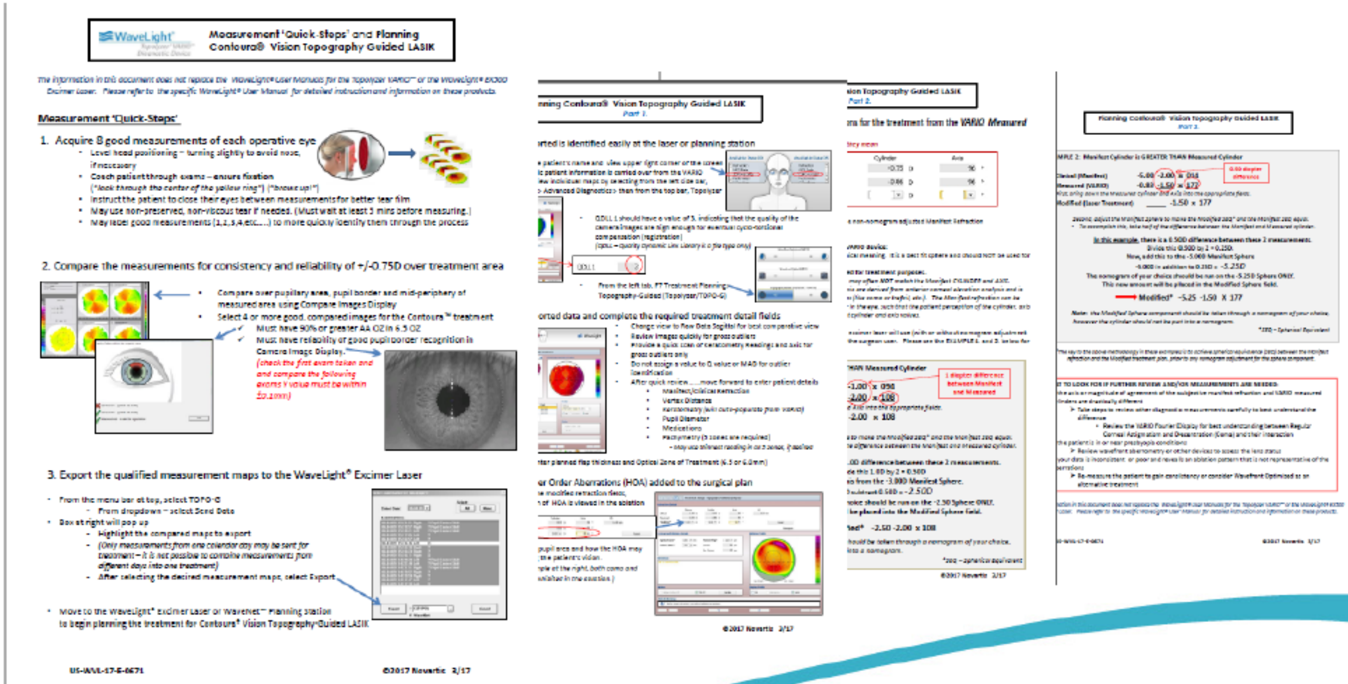
This article was published in the following Dove Press journal:
Clinical Ophthalmology
3 November 2016
Number of times this article has been viewed

Dr. John Kanellopoulos first published significant new findings in a November 2016 clinical paper[3] **which demonstrated that by modifying the clinical refraction (manifest) with topography-guided data for the laser treatment, with regard to the amount and axis of astigmatism**, appears to offer superior visual function in patients post-operatively.

[3]John Kanellopoulos, MD. Clinical Ophthalmology (Nov. 2016). "Topography-modified refraction (TMR): adjustment of treated cylinder amount and axis to the topography versus standard clinical refraction in myopic topography-guided LASIK"

NEW TRAINING DOCUMENT

MEASUREMENT 'QUICK-STEPS' AND *PLANNING CONTOURA® VISION TOPOGRAPHY GUIDED LASIK*



Measurement 'Quick-Steps' and Planning Contoura® Vision Topography Guided LASIK

The information in this document does not replace the WaveLight® User Manuals for the Topolyzer VARIO™ or the WaveLight® EX500 Excimer Laser. Please refer to the specific WaveLight® User Manual for detailed instruction and information on these products.

Measurement 'Quick-Steps'

1. Acquire 8 good measurements of each operative eye
   - Level head positioning – turning slightly to avoid nose, if necessary
   - Coach patient through exams – ensure fixation ("look through the center of the yellow ring") ("brows up!")
   - Instruct the patient to close their eyes between measurements for better tear film
   - May use non-preserved, non-viscous tear if needed. (Must wait at least 3 mins before measuring.)
   - May label good measurements (1,2,3,4,etc....) to more quickly identify them through the process

2. Compare the measurements for consistency and reliability of +/-0.75D over treatment area
   - Compare over pupillary area, pupil border and mid-periphery of measured area using Compare Images Display
   - Select 4 or more good, compared images for the Contoura™ treatment
     - ✓ Must have 90% or greater AA OZ in 6.5 OZ
     - ✓ Must have reliability of good pupil border recognition in Camera Image Display.

   (check the first exam taken and and compare the following exams Y value must be within ±0.1mm)

3. Export the qualified measurement maps to the WaveLight® Excimer Laser
   - From the menu bar at top, select TOPO-G
     - From dropdown – select Send Data
   - Box at right will pop up
     - Highlight the compared maps to export
     - *(Only measurements from one calendar day may be sent for treatment – it is not possible to combine measurements from different days into one treatment)*
     - After selecting the desired measurement maps, select Export
   - Move to the WaveLight® Excimer Laser or WaveNet™ Planning station to begin planning the treatment for Contoura® Vision Topography-Guided LASIK

US-WVL-17-E-0671 ©2017 Novartis 3/17

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a Novartis company

WaveLight® REFRACTIVE PORTFOLIO

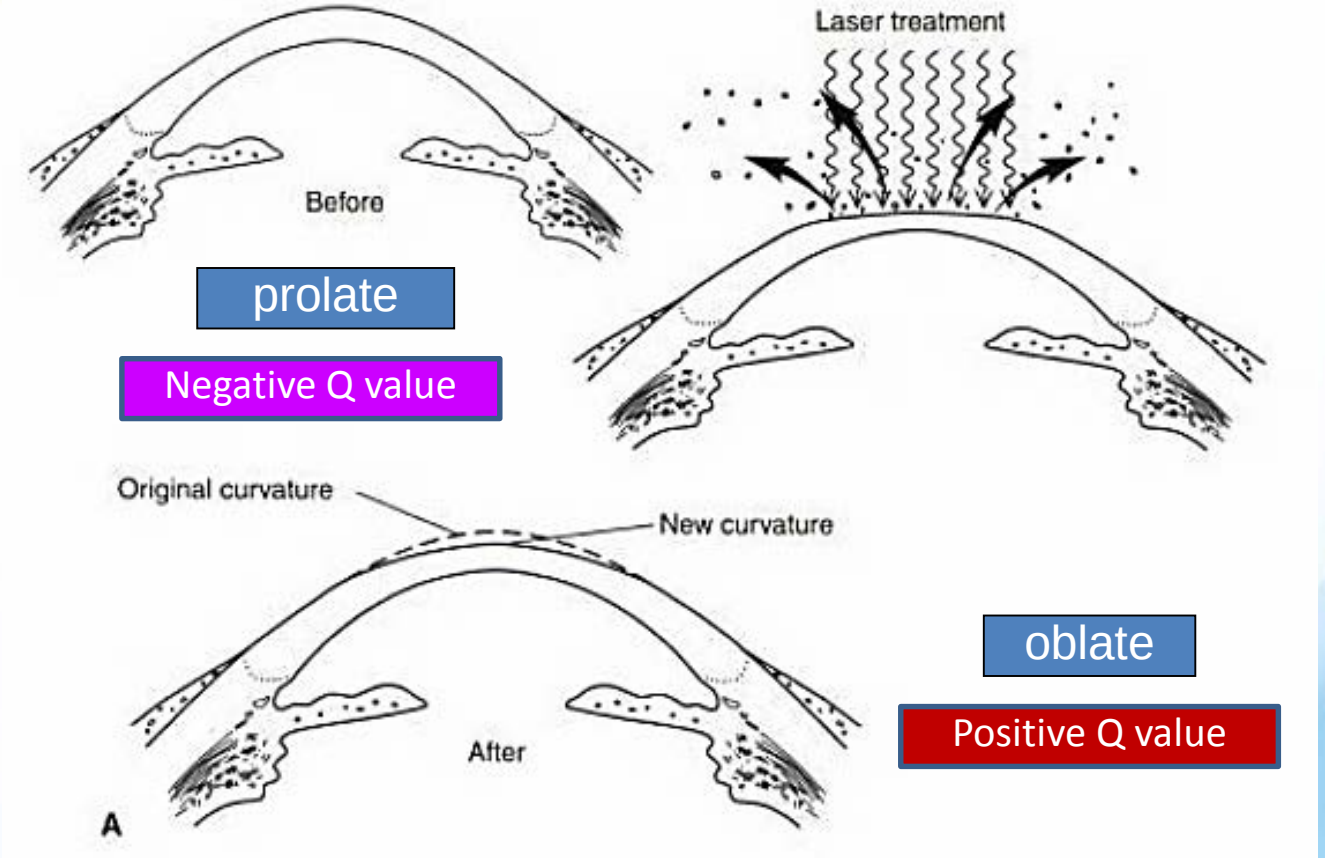
Advancing REFRACTIVE SURGERY

Topography guided Ablation

WaveLight EX500 -Topo- guided ablation techniques:

- ใช้แก้ปัญหา night vision, BCDVA <20/20, RMS pre-op > 0.4 u
- มีการ compensate C12 (spherical aberration) ที่เป็นต้นเหตุ quality of vision
- ใช้ค่า topo จาก topolyzer หรือ analyzer
- ต้องได้ภาพถ่ายที่ดี อย่างน้อย 4 ภาพ
- Laser ablation แบบเดียวกับ WFO
- Centering laser at corneal vertex
- ต้อง keep pupil size ให้ใกล้เคียงกับภาพถ่าย

Corneal recontouring by excimer laser



Correction of **Myopia**

BCSC, Refractive surgery

Custom Q Ablation

- Q- value customized ablation
- Aspheric ablation
- Use a value of the mean corneal asphericity
- Symmetrically adjusting the number of mid-peripheral laser pulses

Custom Q Ablation

WaveLight EX500 –Custom Q ablation technique:

- แก้ตามค่าสายตาที่ทำการตั้งค่า
- เครื่องจะนำค่า Q ที่ได้จาก topolyzer มาคำนวณ ในการยิงเลเซอร์ด้วย เพื่อ keep Q post-op ให้ใกล้เคียงกับ pre-op
- ปรับ Sphere และ cylinder step 0.1 D
- ปรับ transition zone 0.05 mm
- ปรับค่า Q target ได้ แต่ไม่แนะนำ
- ยิงทั้ง Sphere และ cylinder ไปพร้อมกัน

ORIGINAL ARTICLE

Wavefront Optimized Versus Custom-Q Treatments in Surface Ablation for Myopic Astigmatism With the WaveLight ALLEGRETTO Laser

Aleksandar Stojanovic, MD; Ling Wang, MD, MS; Mirko R. Jankov, MD, PhD; Tore A. Nitter, MD, PhD; Qinmei Wang, MD

ABSTRACT

PURPOSE: To compare treatments with wavefront optimized and custom-Q ablations.

METHODS: Two consecutive groups of eyes were treated for myopia and astigmatism with surface ablation. One group was treated with wavefront optimized ablation and the second group was treated with custom-Q ablation. Preoperative and 3-month postoperative Q-values, higher order aberrations, low contrast visual acuity, and classic outcome parameters were analyzed.

RESULTS: The wavefront optimized ablation group was comprised of 46 eyes of 23 patients with a mean spherical equivalent refraction (SE) of −3.64 diopters (D) (range: −1.15 to −8.25 D); mean Q-value changed from −0.33 preoperatively to 0.06 postoperatively. The custom-Q ablation group was comprised of 42 eyes of 21 patients with a mean SE of −3.24 D (range: −1.47 to −8.00 D); mean Q-value changed from −0.36 preoperatively to −0.03 postoperatively. A statistically significant difference in postoperative change in Q-values (P=.049) between the two groups was noted, but there was no such difference in higher order aberrations, low contrast visual acuity, or classic outcome parameters.

CONCLUSIONS: Custom-Q ablation resulted in a mean postoperative asphericity that was closer to preoperative compared to wavefront optimized ablation, whereas the other outcome parameters showed no statistically significant differences. [*J Refract Surg.* 2008;xx:xxx-xxx.]

One problem with standard myopic excimer laser treatment is decrease in visual performance manifested by reduction in contrast sensitivity and night vision.[1] It has been reported that these treatments induce an increase in spherical aberration[2] and that such increase was mainly related to change of corneal asphericity.[3,4] The curvature of the anterior surface of an aspheric cornea changes with distance from the apex so that the surface flattens towards the periphery in prolate corneas but steepens towards the periphery in oblate corneas. To describe this change in curvature or asphericity, Q
Q-value describes a prolate su
describes an oblate surface.
myopic ablation changes the n
an oblate direction,[5] and this
related with the amount of c
ablations, with considerations
this oblate shift but typically b
tive towards high degrees of m

This study compares the Wa
Light AG, Erlangen, Germany)
and its custom-Q treatment. T
tion has an aspheric profile in
ity is not adjustable (and is the
platform). Similarly, the custo
ic ablation, but it adds the ab

From the Eye Department, University H Kirurgi, Tomsø, Norway (Stojanovic); S and Eye Hospital, Wenzhou Medical Wang, Q. Wang); Milos Klinika, Mea Belgrade, Serbia (Jankov); and Øyelege

This study was supported by SynsLase

Dr Jankov is a paid consultant for WaveLight AG, Erlangen, Germany. The remaining authors have no proprietary or financial interest in the materials presented herein.

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Accepted: November 7, 2007

CONCLUSIONS: Custom-Q ablation resulted in a mean postoperative asphericity that was closer to preoperative compared to wavefront optimized ablation, whereas the other outcome parameters showed no statistically significant differences. [*J Refract Surg.* 2008;xx:xxx-xxx.]

SMGroup

SM Ophthalmology Journal

Rapid Communication

Custom-Q *vs* Wavefront Optimized Lasik Ablation Treatment Profile in High Myopic Asian Eyes

Elsa LC Mai[1], Iebin Lian[2], Chih-Cheng Lin[3] and Chaokai Chang[4]*

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Article Information

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Abstract

Purpose: To compare the change in asphericity and other Higher Order Aberration (HOA) in Custom-Q *vs.* Wavefront Optimized (WFO) LASIK ablation profile patients in an Asian population.

Setting: Prospective matched-cohort study in refractive center.

group comprised a mean SE of -5.41 diopter (D). Their frequencies with which Custom-Q and WFO achieved postoperative Uncorrected Distance Visual Acuity (UCDVA) were not statistically different from each other (P>0.05). No statistically significant differences were found in contrast sensitivity, astigmatism, coma, and trefoil. However, the change of spherical aberration was higher in the WFO ablation profile. Patient questionnaire shows a mild preference for Custom-Q over WFO.

Conclusion: Custom-Q and WFO LASIK provided similar results in myopic refractive correction and achieved post op UCDVA and contrast sensitivity. However, Custom-Q produced less changes in asphericity and HOA changes; Asian patients showed marginal preference for Custom-Q in terms of optic quality.

Conclusion: Custom-Q and WFO LASIK provided similar results in myopic refractive correction and achieved post op UCDVA and contrast sensitivity. However, Custom-Q produced less changes in asphericity and HOA changes; Asian patients showed marginal preference for Custom-Q in terms of optic quality.

Keywords Myopia; Eye aberrations; LASIK; Keratoconus; Visual acuity; Asphericity; Presbyopia

WaveLight EX500
WFO vs Custom Q

WFO	Custom Q
• แก้ตามค่าสายตาที่ทำการตั้งค่า • ปรับ Sphere และ Cylinder step 0.5 D • ไม่สามารถปรับ transition zone • Sequentially ablation: sphere then cylinder	• แก้ตามค่าสายตาที่ทำการตั้งค่า • ปรับ Sphere และ cylinder step 0.1 D • ปรับ transition zone 0.05 mm • เครื่องจะนำค่า Q ที่ได้จาก topolyzer มาคำนวณ ในการยิงเลเซอร์ด้วย เพื่อ keep Q post-op ให้ใกล้เคียงกับ pre-op • ยิงทั้ง Sphere และ cylinder ไปพร้อมกัน

Photoablation Outline

- Techniques
- Outcomes
- Complications and Adverse Effects

- Efficacy
- Predictability
- Stability
- Safety

Refractive Surgery Outcomes

- Efficacy .....% UCDVA ≥ 20/20

  Un-corrected *distance* VA

Refractive Surgery Outcomes

- Efficacy
- Predictability .....% PO refraction $\pm$ 1.0 D
- Stability
- Safety

Refractive Surgery Outcomes

- Efficacy
- Predictability
- Stability ……% SE, K in 6, 12, …….months
- Safety

Refractive Surgery Outcomes

- Efficacy
- Predictability
- Stability
- Safety ……% lost 2 or more lines of BCVA

Refractive Surgery Outcomes in CMU LASIK Center

The Open Ophthalmology Journal, 2018, *12*, 63-71 63

BENTHAM OPEN

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The Open Ophthalmology Journal

Content list available at: www.benthamopen.com/TOOPHTJ/

DOI: 10.2174/1874364101812010063

RESEARCH ARTICLE

Outcomes of LASIK for Myopia or Myopic Astigmatism Correction with the FS200 Femtosecond Laser and EX500 Excimer Laser Platform

Muanploy Niparugs, Napaporn Tananuvat, Winai Chaidaroon, Chulaluck Tangmonkongvoragul and Somsanguan Ausayakhun*

Chiang Mai University LASIK Center, Center for Medical Excellence, and Department of Ophthalmology, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand

Received: January 21, 2018 Revised: March 28, 2018 Accepted: April 25, 2018

Abstract:

Photoablation Outline

- Techniques
- Outcomes
- Complications and Adverse Effects

- Efficacy
- Predictability
- Stability
- Safety
- HOA : glare, halo, starburst, contrast sensitivity

Photoablation Outline

- Techniques
- Outcomes
- Complications

and Adverse Effects

- Intra-operative
- Post- operative

Photoablation Complications and Adverse Effects

Intra-operative:

- Flap-related
- Laser-related

Post-operative:

- Infection/DLK
- Flap displace/striae/epithelial ingrowth
- Ectasia
- Cataract / glaucoma / RD
- Dry eyes
- Glare/halo

Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- UCDVA
- Infection/DLK
- Dry eyes
- Glare and halos
- Regression/Enhancement
- Presbyopia
- Flap complications
- Air bubble in AC
- Ectasia
- Cataract / glaucoma / RD
- Etc.

Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- UCDVA

VA	≥ 20/25	≥ 20/20
Mild	99%	98%
Moderate	97%	96%
Severe	96%	95%

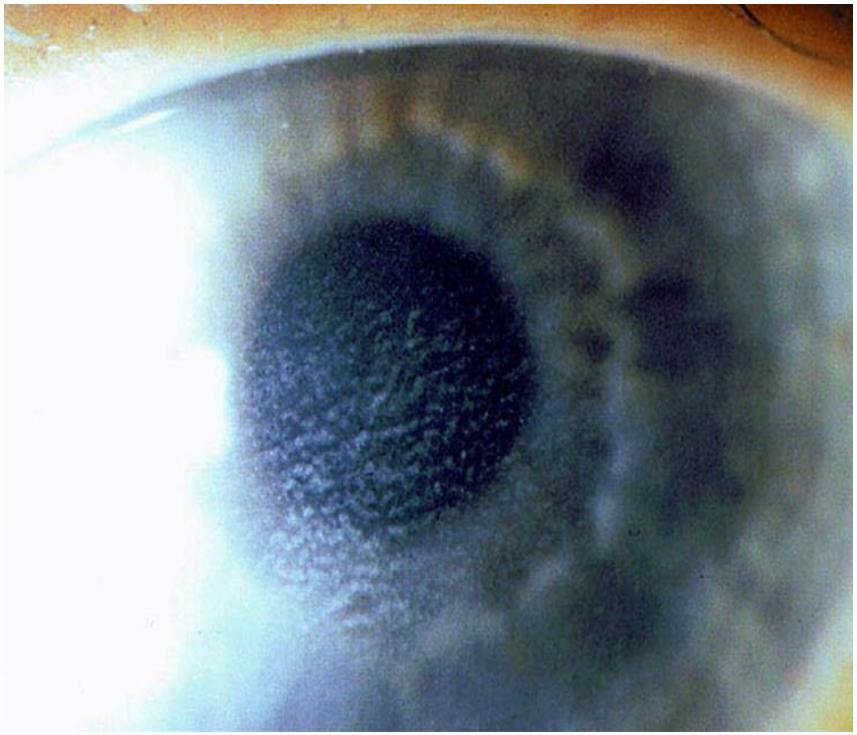
Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- Infection/DLK

ล้างหน้า-สระผม ไม่ให้น้ำเข้าตา 2 สัปดาห์
งดว่ายน้ำ 1 เดือน
งดดำน้ำ 2-3 เดือน

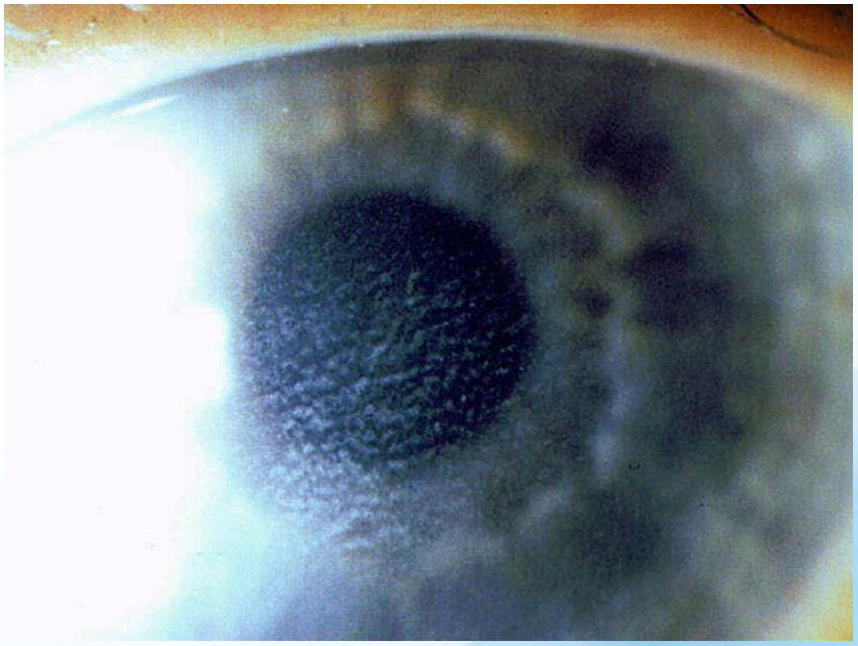
DLK
(Diffuse Lamellar Keratitis)



- Sands of Sahara Syndrome

DLK
(Diffuse Lamellar Keratitis)

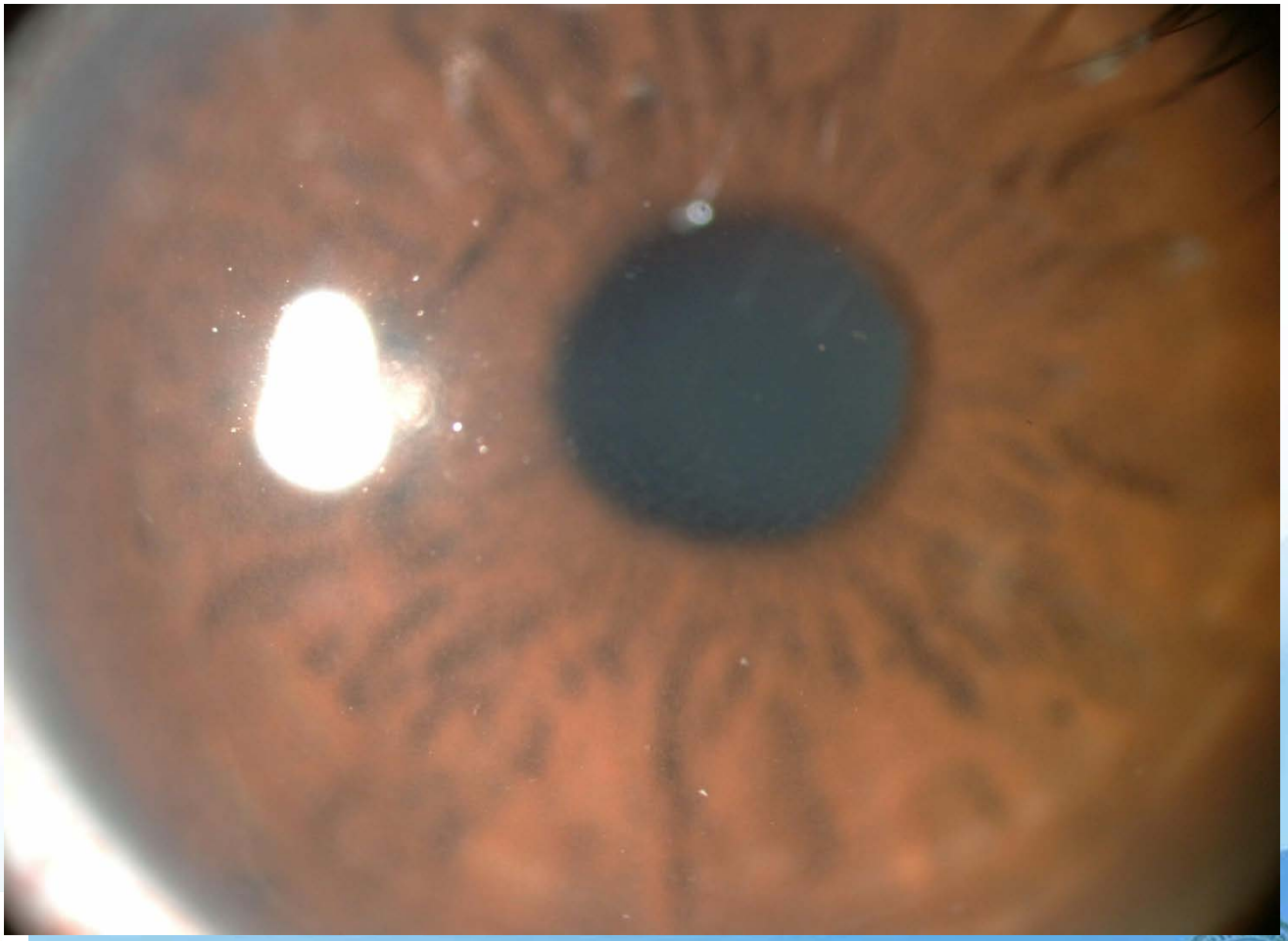
- Nonspecific sterile inflammation
- Due to a variety of mechanical and toxic insults



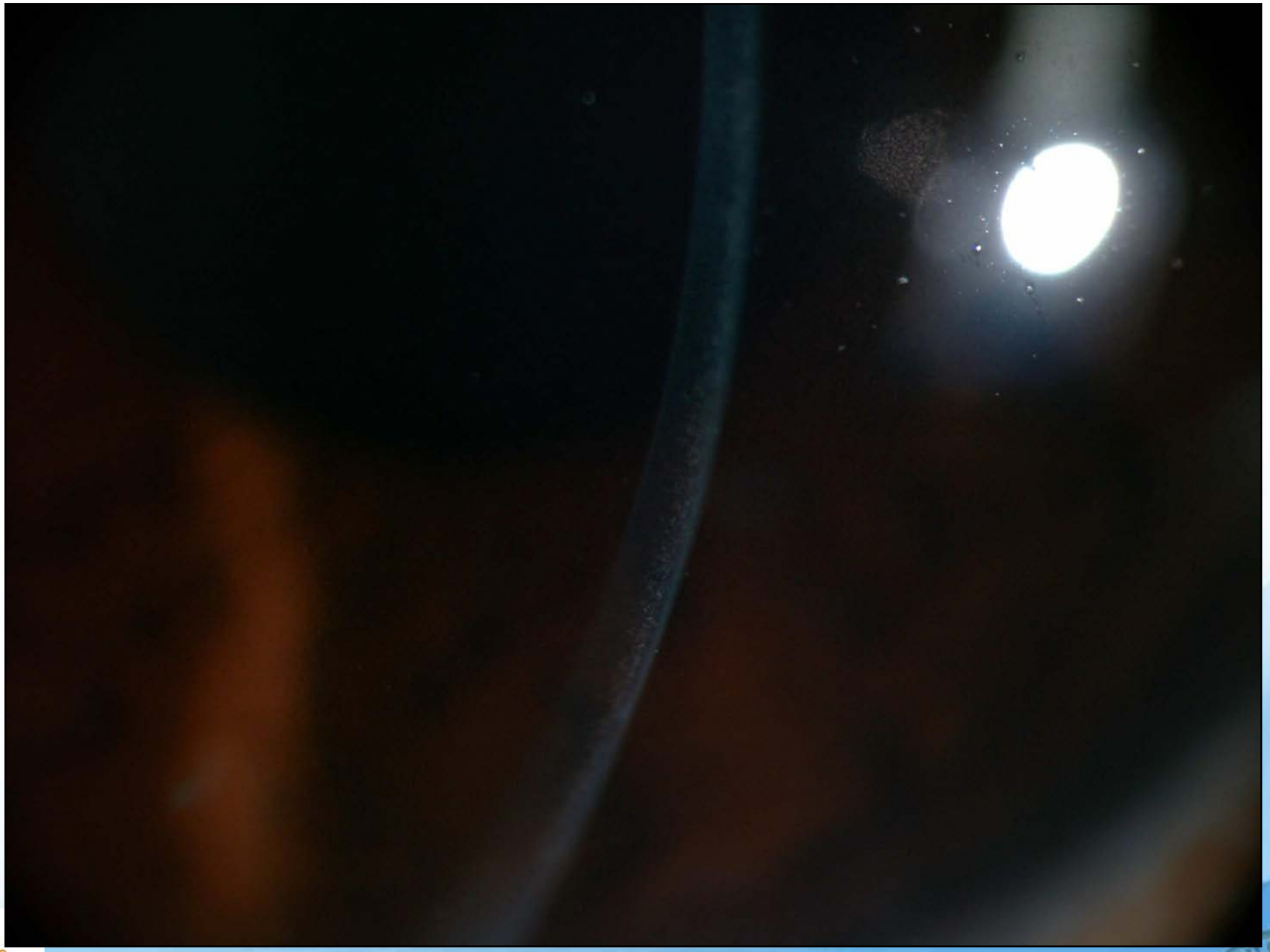
Staging DLK

Stage	Findings Treatment
1	Peripheral faint WBC; granular appearance Topical steroid
2	Central scattered WBC; granular appearance Topical steroid
3	Central dense WBC in visual axis Lifting the flap w irrigation NSS
4	Permanent scarring or stromal melting

DLK
(Diffuse Lamellar Keratitis)



DLK
(Diffuse Lamellar Keratitis)



Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- Dry eyes

COMOD System

Reduce after 3-6 months

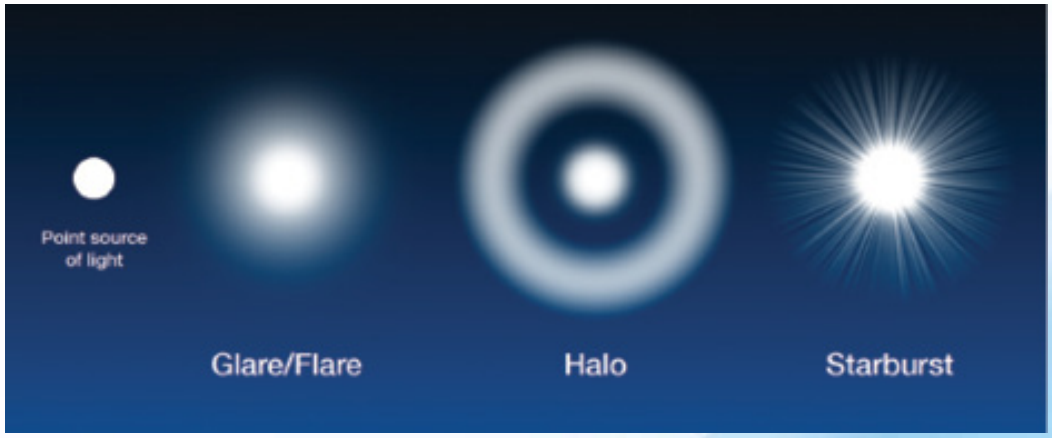
PRK < LASIK (>SMILE ?)

Only non-preservative artificial tears!!!!

Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- Glare and halos
  1. Dry eyes
  2. pupil size @ night
- Presbyopia



Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- Regression/Enhancement

CMU LASIK Center : Residual stromal bed > 300 u

Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- Presbyopia

- Reading glasses
- Monovision
- NV LASIK/PRK

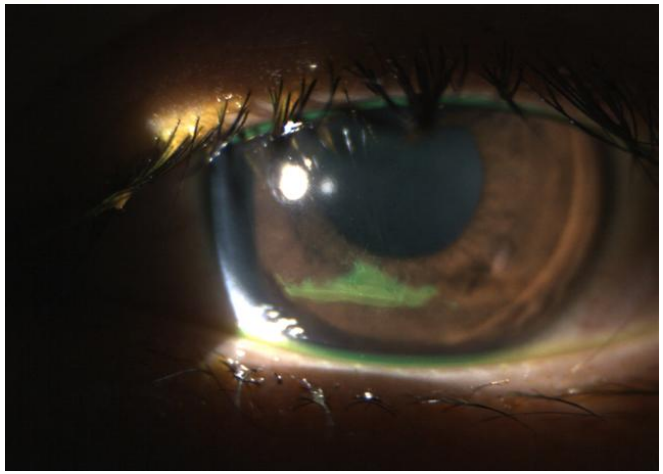
Photoablation Complications and Adverse Effects

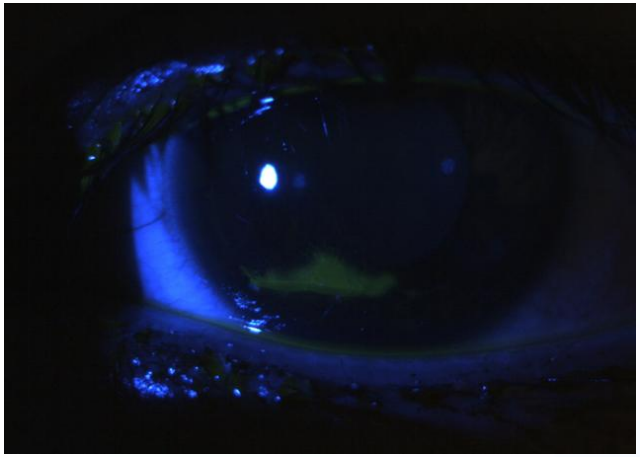
Discuss in detail (CMU LASIK CENTER):

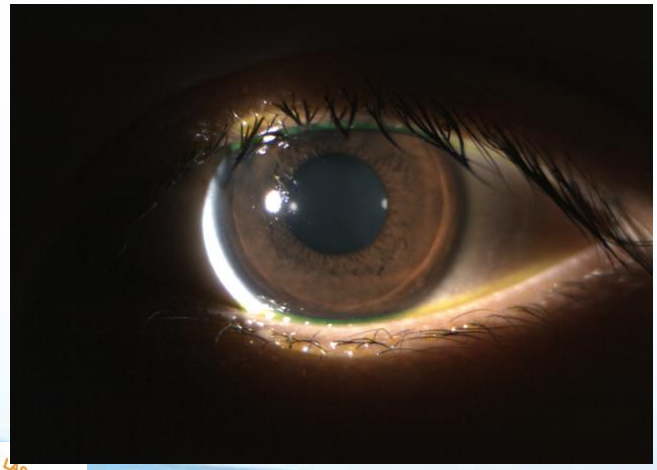
- Incomplete flap: re-Sx 3 mo
- Flap displacement
- Flap striae

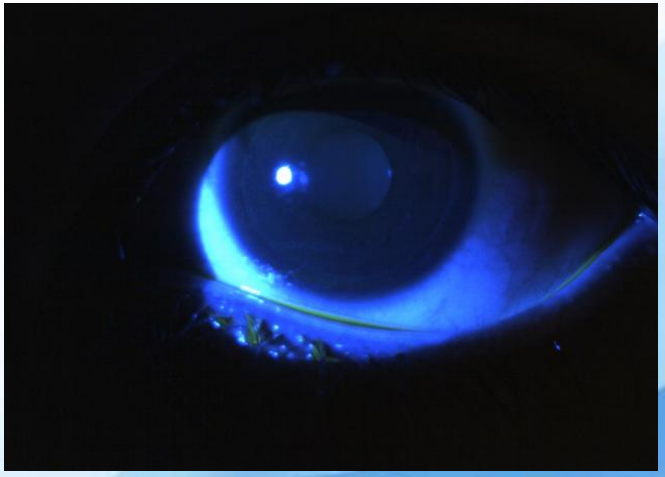
- Flap complications
- Regression/Enhancement
- Presbyopia
- Cataract / glaucoma / RD
- Etc.

Flap complications: partial incomplete flap

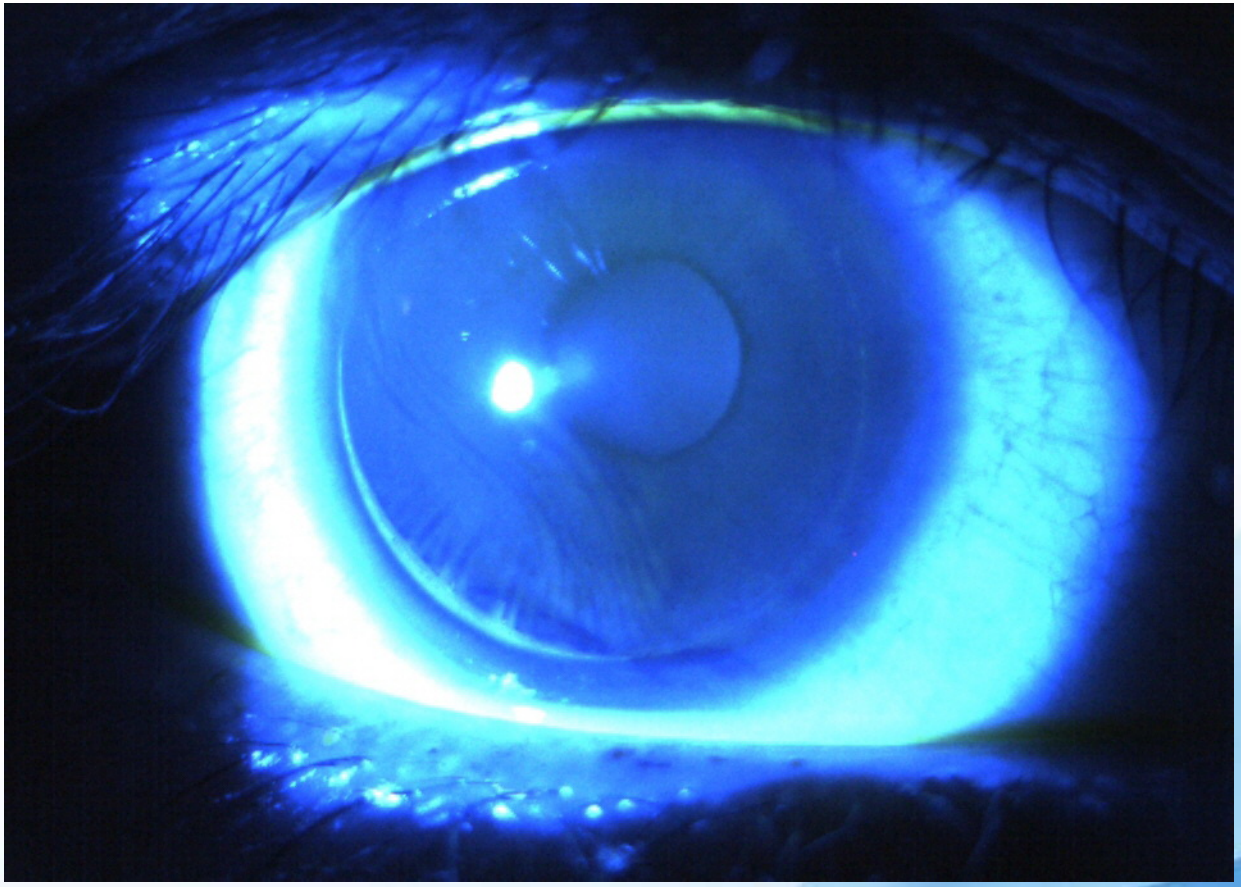






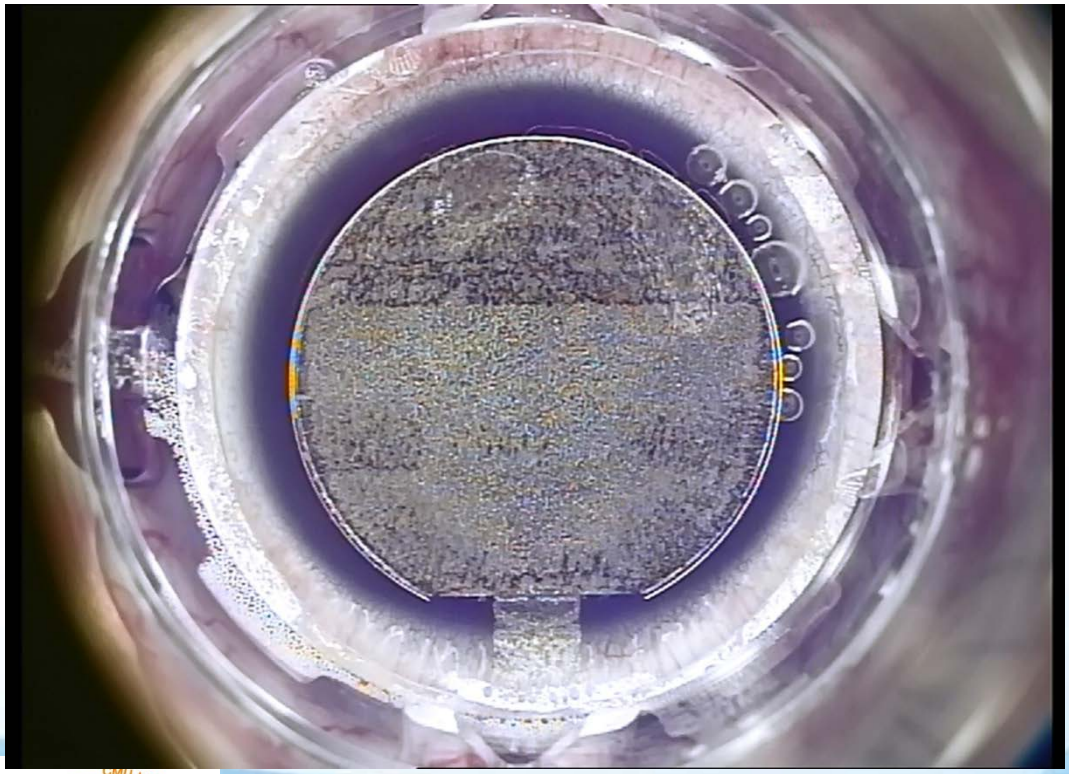


Flap complications: flap displacement



Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):



- Air bubble in AC

Anterior chamber gas bubbles during femtosecond laser flap creation

Somsanguan Ausayakhun, MD, MHSc, Winai Chaidaroon, MD, Napaporn Tananuvat, MD, Chulaluck Tangmonkongvoragul, MD, Muanploy Niparugs, MD

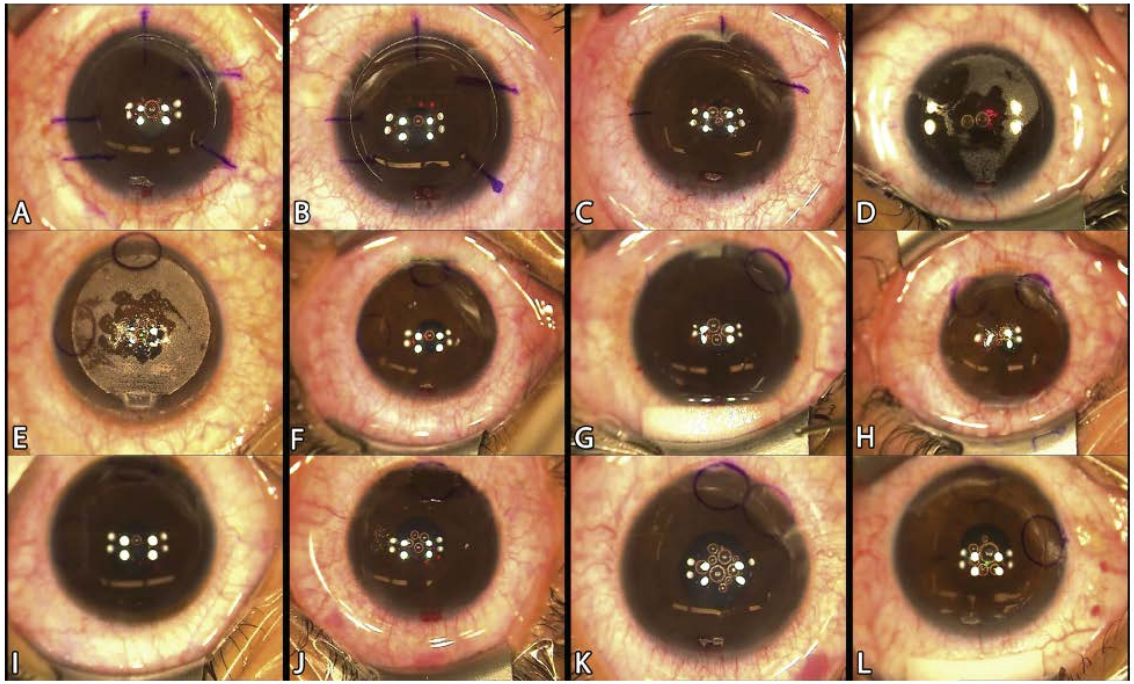


Figure 1. Air bubbles in the anterior chamber after flap creation with the femtosecond laser: *A* = patient 1, *B* = patient 2 (right eye), *C* = patient 2 (left eye), *D* = patient 3, *E* = patient 4, *F* = patient 5, *G* = patient 6, *H* = patient 7, *I* = patient 8, *J* = patient 9 (right eye), *K* = patient 9 (left eye), *L* = patient 10. (There are no photographs of patients 11 and 12.)

ubbles were produced by the Wave-
eusis. The parameters for femtosec-
in each eye before excimer ablations
y postoperatively, the uncorrected
1 4 eyes, 20/32 in 1 eye, and 20/40
/20 in 4 eyes, and 20/25 in 2 eyes.
ıber gas bubbles, in our cases this

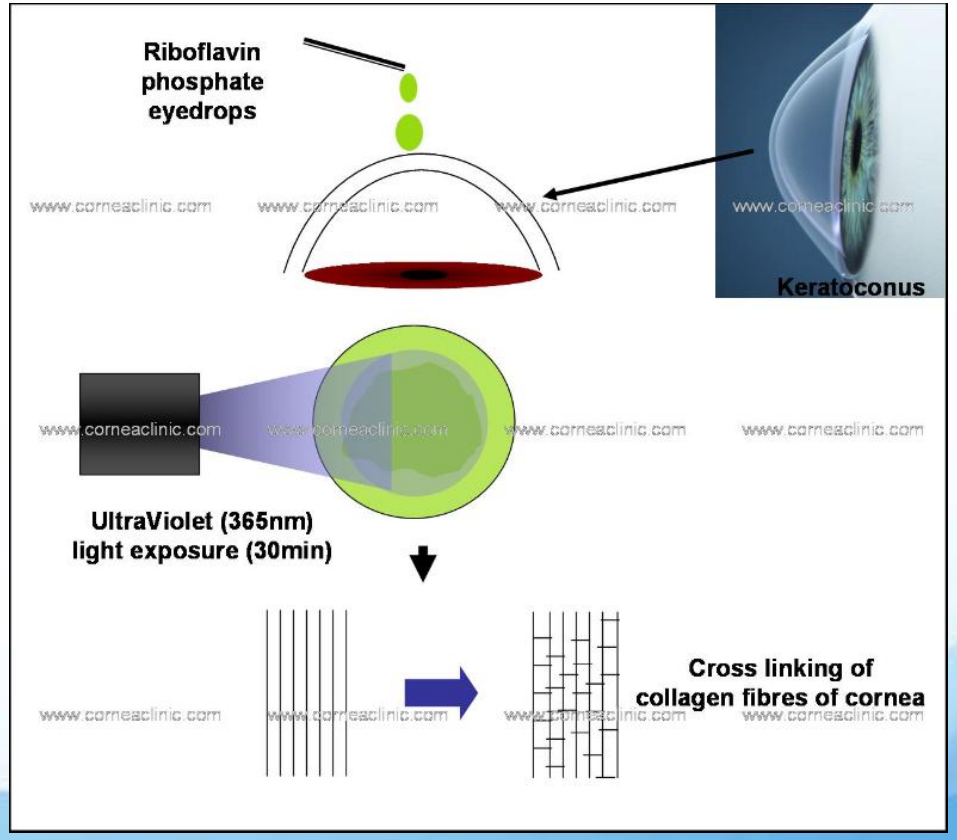
roprietary interest in any material or

d ESCRS.

Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- CXL



- Ectasia

Photoablation Complications and Adverse Effects

Discuss in detail (CMU LASIK CENTER):

- Especially in high myopia > 6.00 D
- Cataract / glaucoma / RD
- Etc.

CMU LASIK Center

CMU LASIK CENTER
since 12-12-2012

CMU LASIK CENTER
2018

WaveLight FS200 (Femtosecond Laser)

WaveLight FS200

- 200 KHz laser speed, < 2uJ
- Creates a 9.0 mm flap in 6 sec.
- Total procedure time, “suction on” to “suction off” ~ 30-45 sec.
- Relocate flap centration after suction on

WaveLight FS200

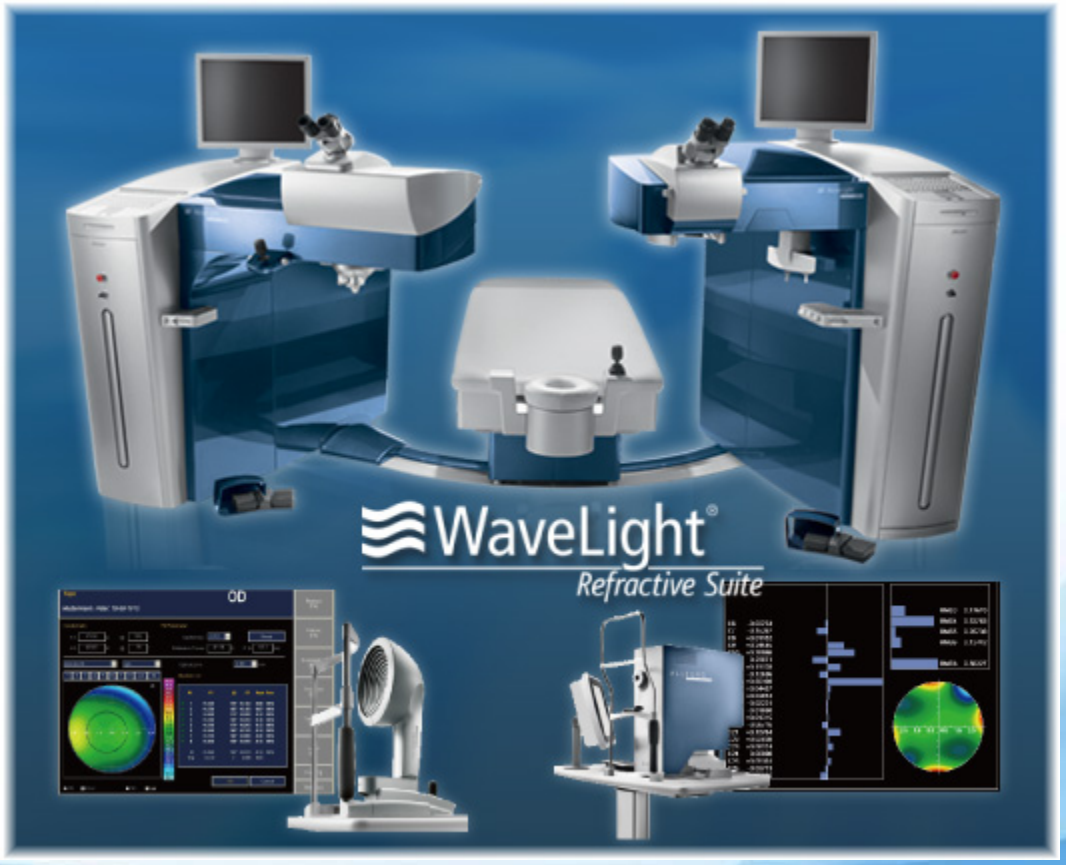
- Opaque bubble layer (OBL) reduction by canal cut for release gas outside the eye
- Adjustable: hinge placement, flap thickness & diameter, and side cut angle
- Applications: Flap, intracorneal ring segments, lamellar keratoplasty (anterior and posterior), penetrating keratoplasty

@ CMU LASIK CENTER

Installed WaveLight Refractive Suite since November 2012:

- EX500 (Excimer Laser)
- FS200 (Femtosecond Laser)
- Topolyzer VARIO – Placido Disc
- Oculyzer II - Pentacam
- Analyzer II - WaveFront
- OB 820 – IOL Measurement
- MK2000 (Microkeratome) – no use

WaveLight Refractive Suite



@ CMU LASIK CENTER

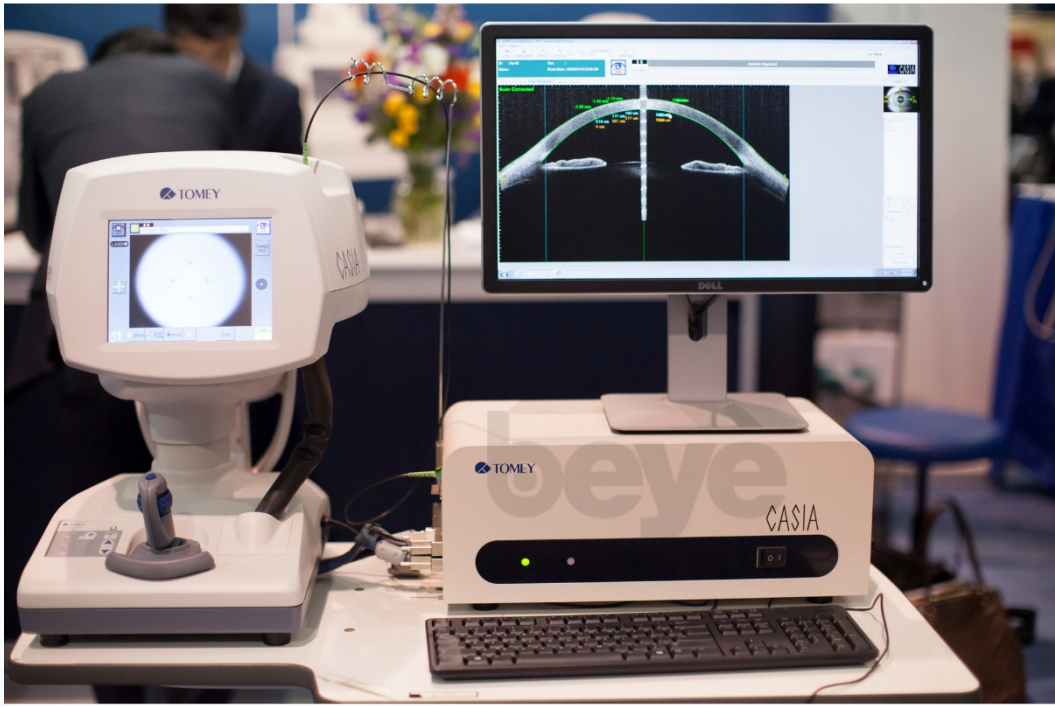
Until 2019

- Anterior photo- Huvitz

@ CMU LASIK CENTER

Until 2019

- Anterior photo- Huvitz
- Anterior OCT-CASIA



@ CMU LASIK CENTER

Until 2019

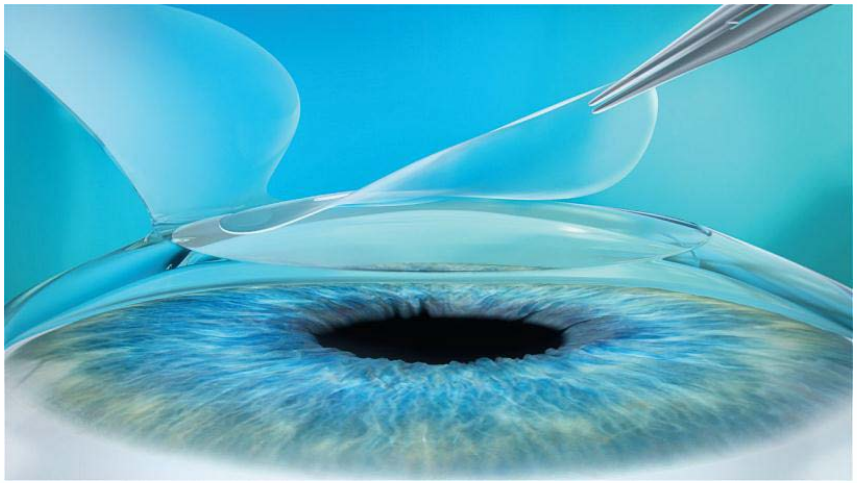
- Anterior photo- Huvitz
- Anterior OCT-CASIA
- Functional Vision Analyzer

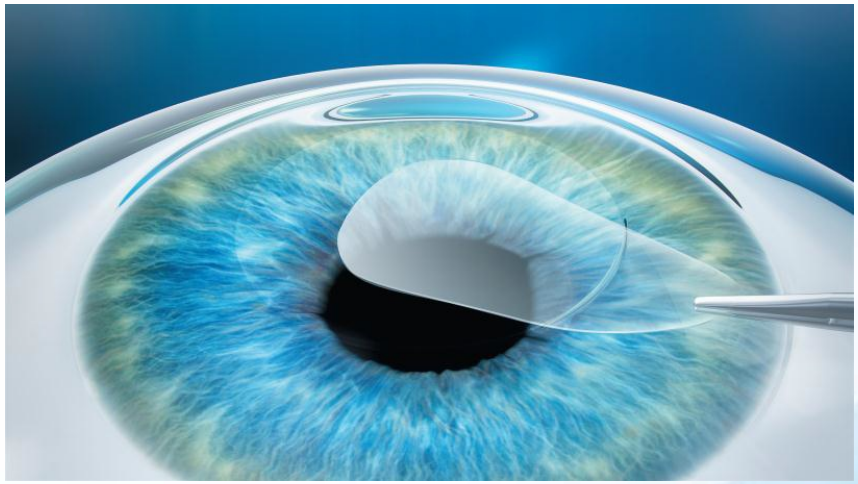
@ CMU LASIK CENTER

Until 2019

- Anterior photo- Huvitz
- Anterior OCT-CASIA
- Functional Vision Analyzer
- Corvis ST (Corneal Visualization Scheimpflug Technology)
- Pentacam

Refractive Lenticular Extraction (ReLex) by FS Laser



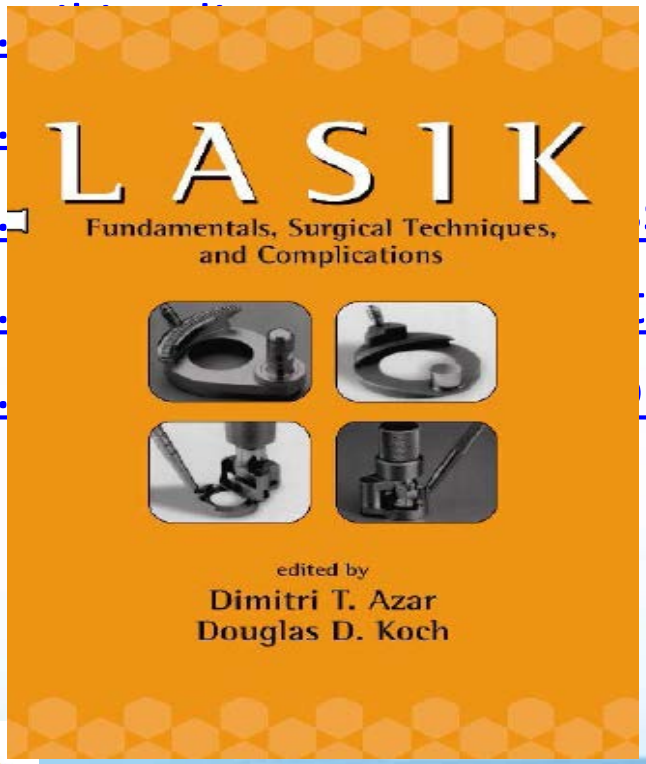


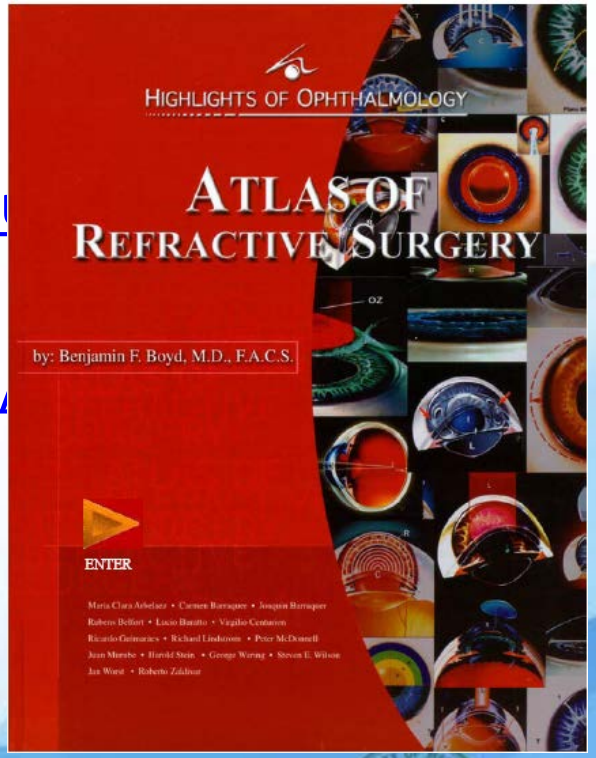
FLEx (Femtosecond Lenticular Extraction)

SmILE (Small Incision Lenticular Extraction)

REFERENCES

- Basic and clinical science course: section 13, Refractive surgery; 2018-2019.
- www.
- www.
- www.
- www.
- www.





Thank you for your attention


Department of
Ophthalmology
Chiang Mai University

questions?


CMU LASIK CENTER
LASIK

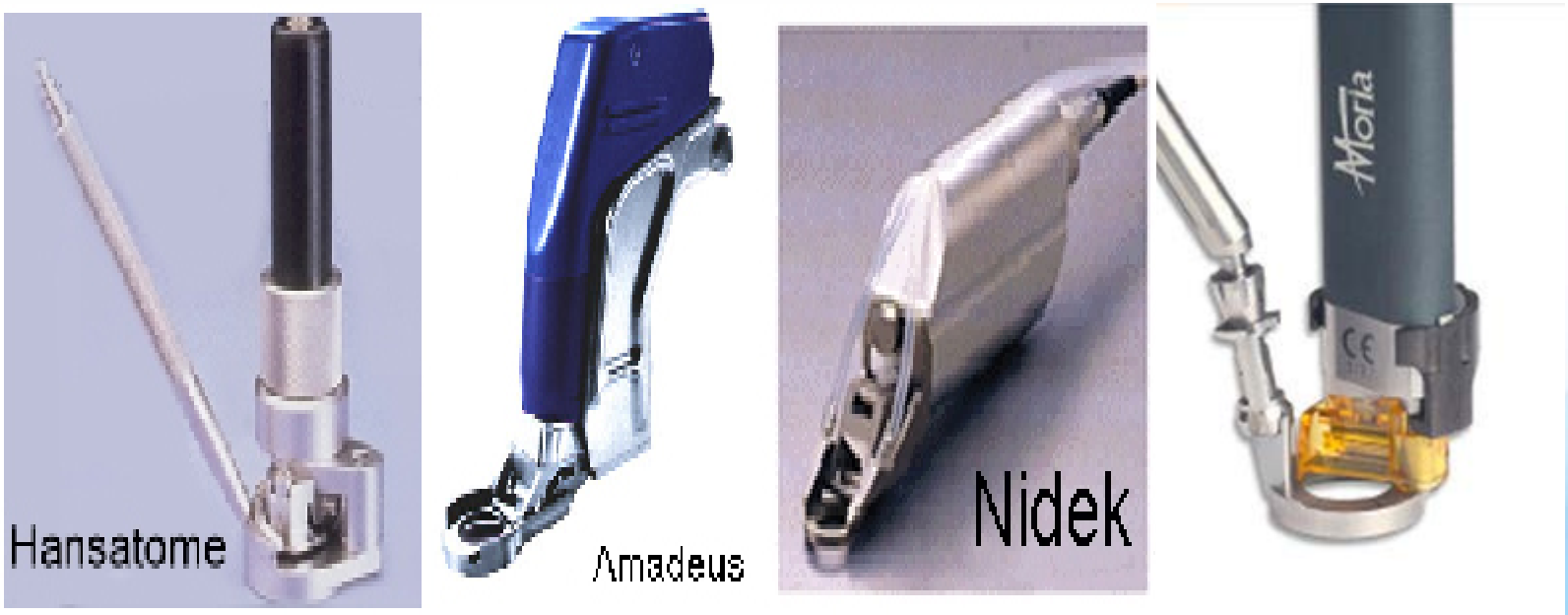
LASIK

- Microkeratome (MK LASIK)
- Femtosecond laser (Femto LASIK)

LASIK

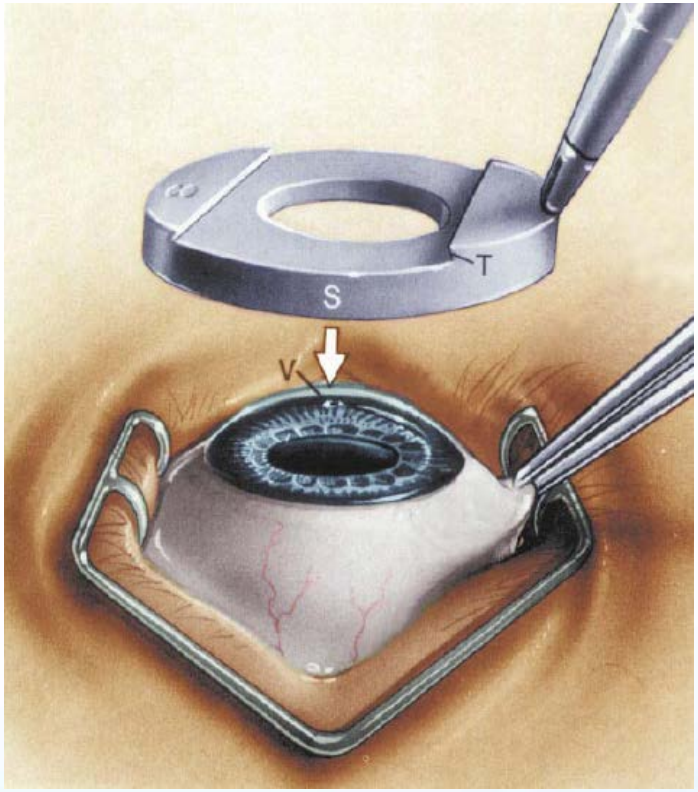
- Microkeratome (MK LASIK)
- Femtosecond laser (Femto LASIK)

MK LASIK



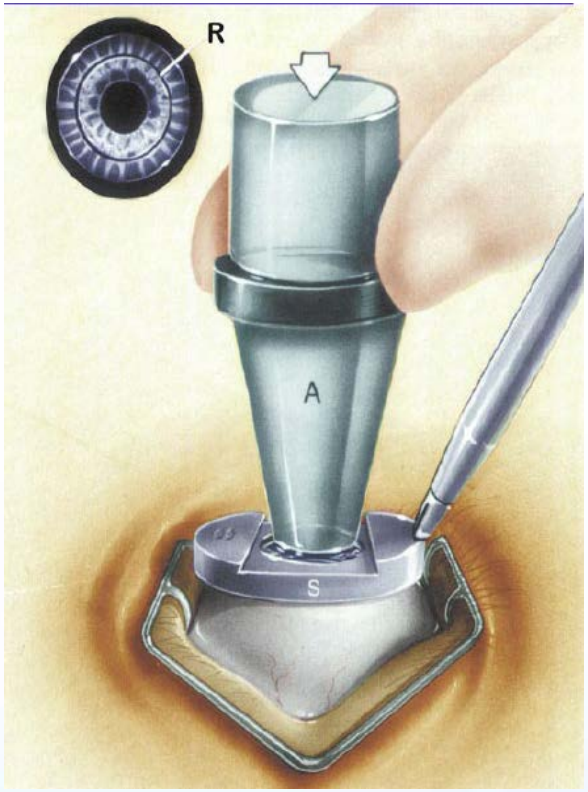
MK blade 160-180 u

MK LASIK 1



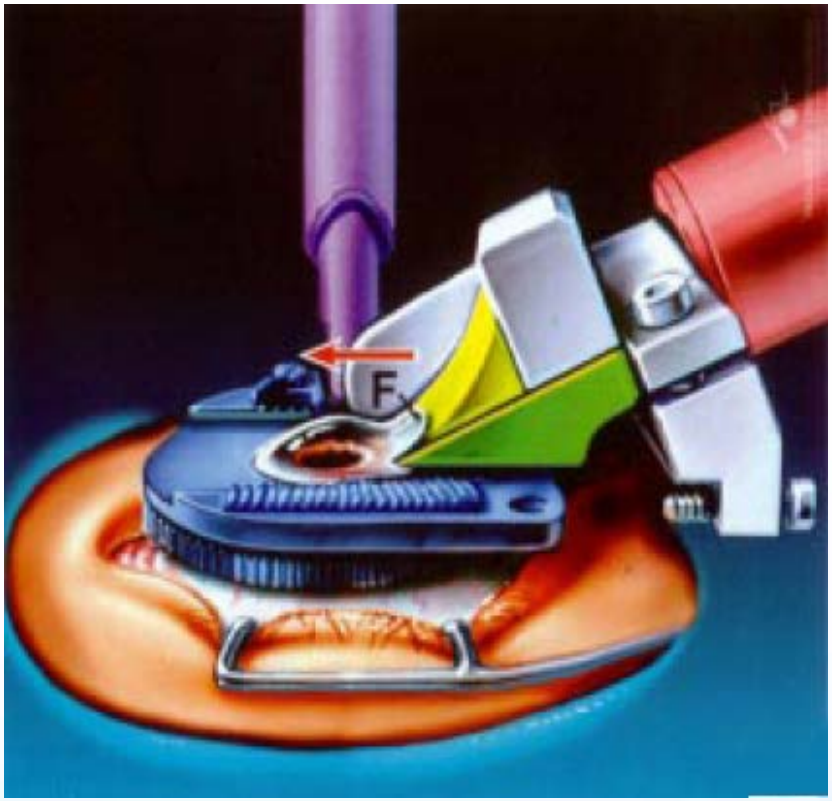
1. Placing the Suction Ring (S)

MK LASIK 2



2. Check pressure > 65 mmHg
by Barraquer Tonometer (A)
& pupil dilate

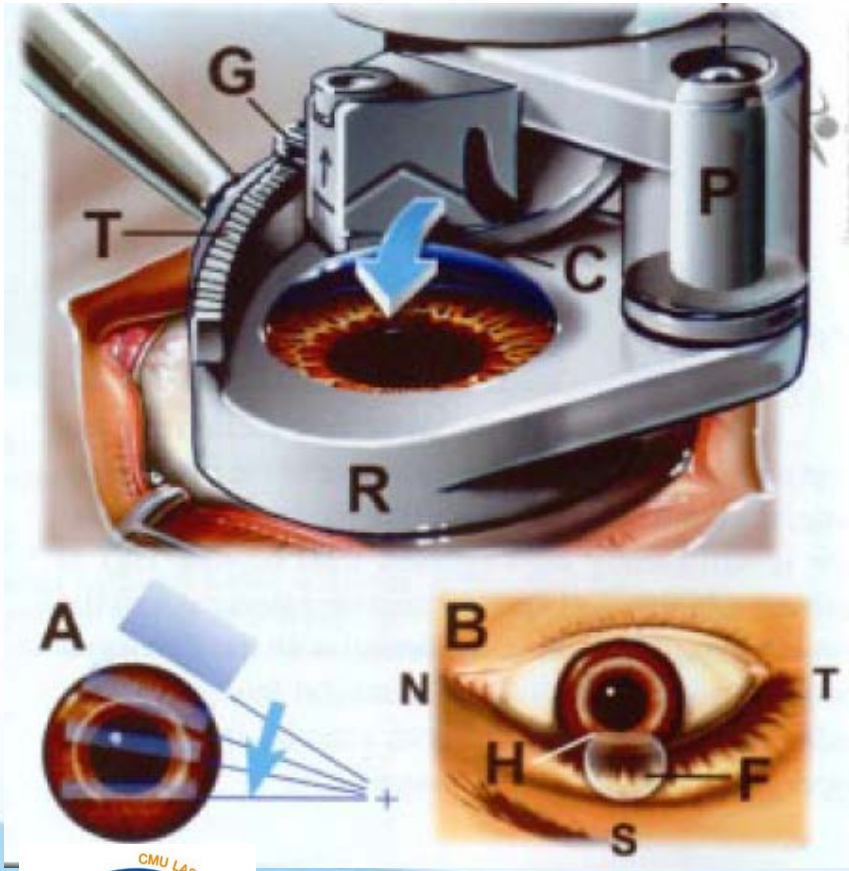
MK LASIK 3



3.Load the microkeratome

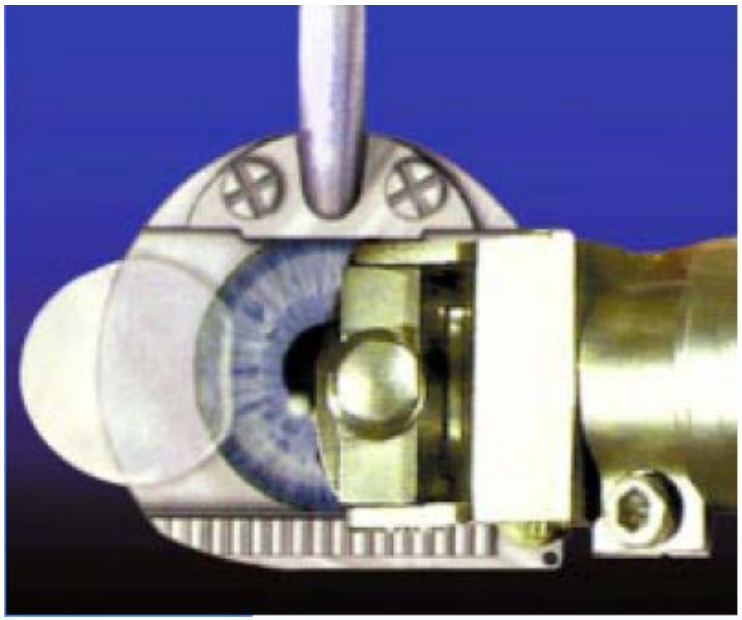
4. Create the corneal flap (F)
   - Linear

MK LASIK 4



- Rotation

MK LASIK 5



5. Reverse the machine
6. Off suction ring

LASIK

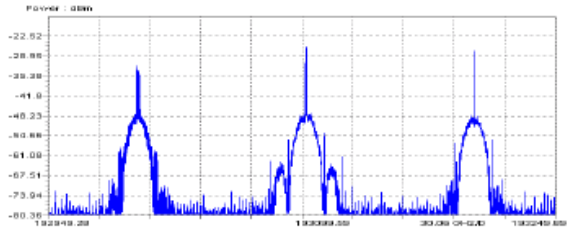
- Microkeratome (MK LASIK)
- Femtosecond laser (Femto LASIK)

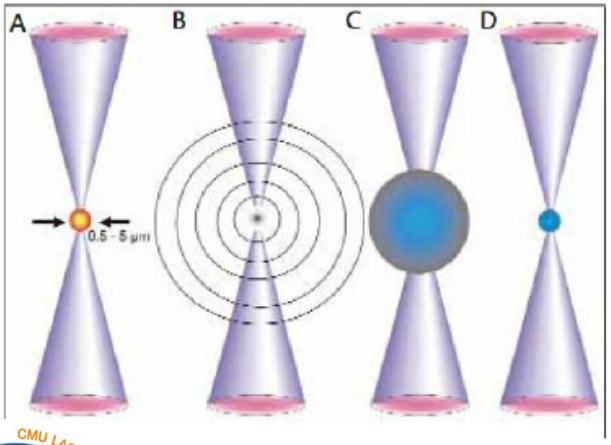
Femtosecond laser LASIK (Femto LASIK)

- Bladeless LASIK
- Blade-free LASIK
- All laser LASIK
- Femtosecond laser = Nd:YAG
- Photodisruption (not cutting)

Femtosecond laser

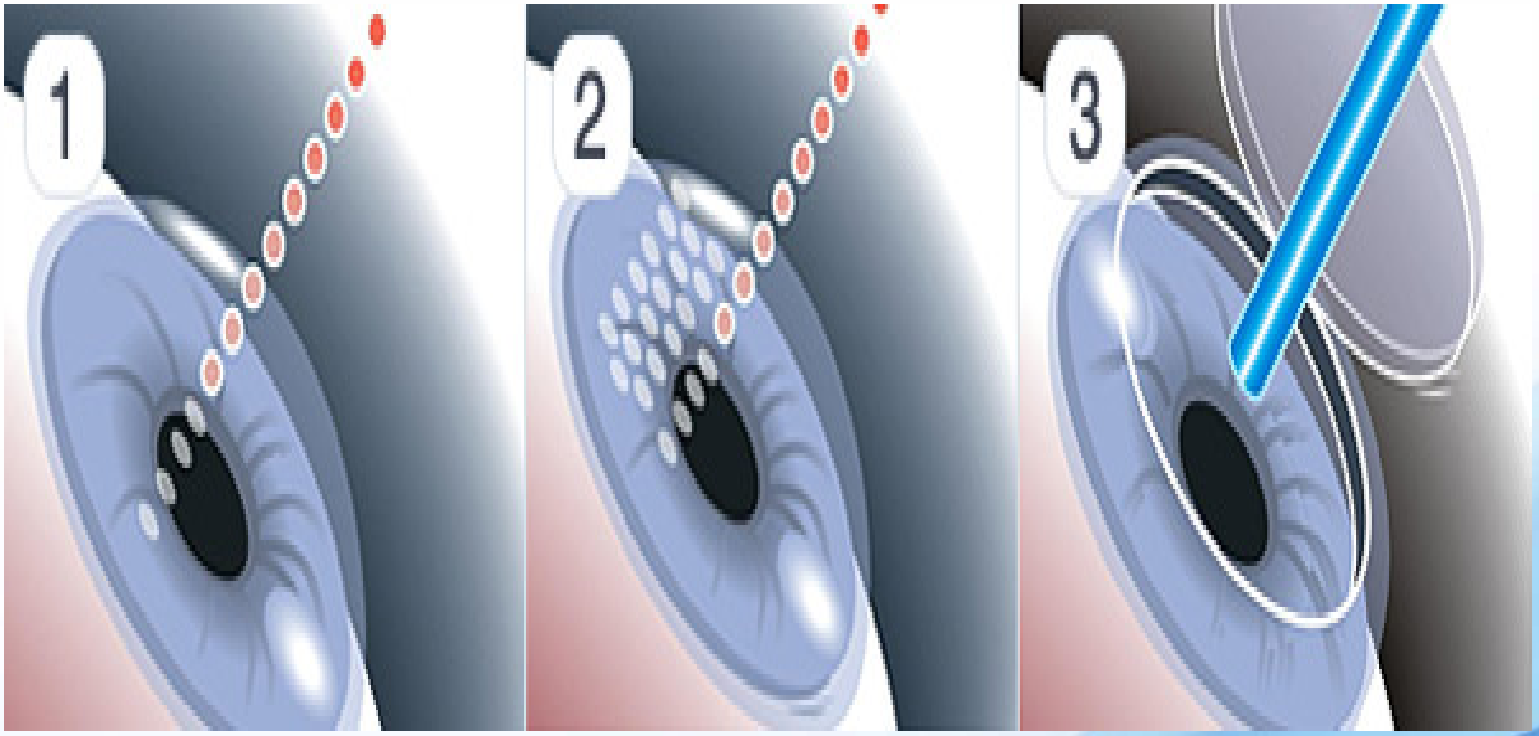
- The definition of a femtosecond is 10^{-15} seconds
  (1.2 seconds for light to travel from the moon to an earthbound observer's retina)
- FSL = Laser emitting in pulse rate of $1/10^{15}$ second
- "Ultra-short pulse laser"
- 1053 nm (Infrared)
- *"Photodisruption"*





(A) Multiphoton absorption → plasma
(B) Expanding plasma drives as acoustic shock wave
(C) Expanding plasma has pushed the surrounding medium away results in a cavitation bubble (10 to 100 µm)
(D) After the collapse of cavitation bubble,a gas bubble is left, containing carbon dioxide& Nitrogen

Femto LASIK



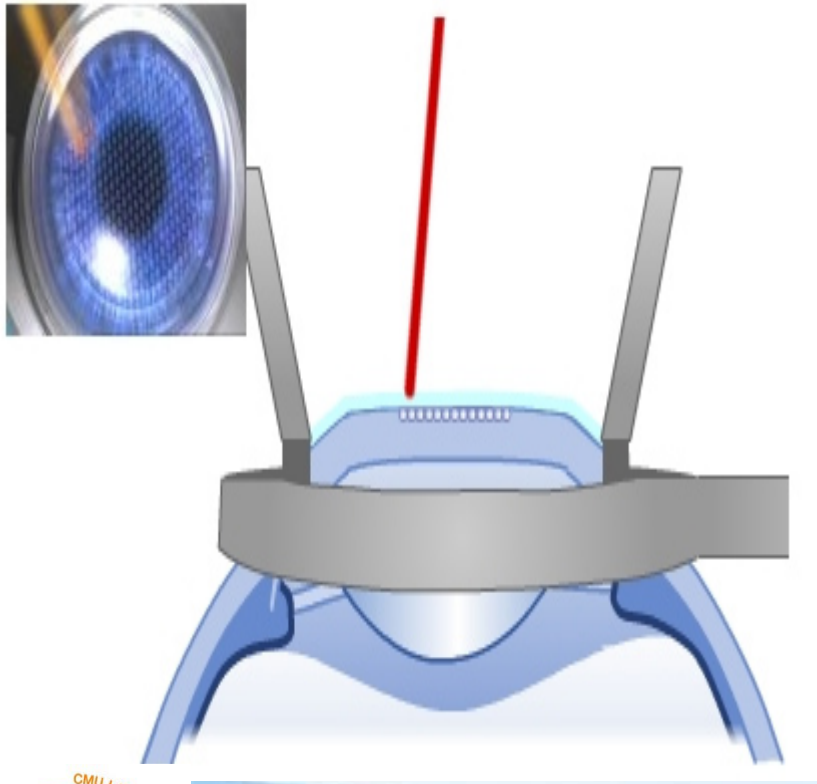
FS flap 90-120 micron

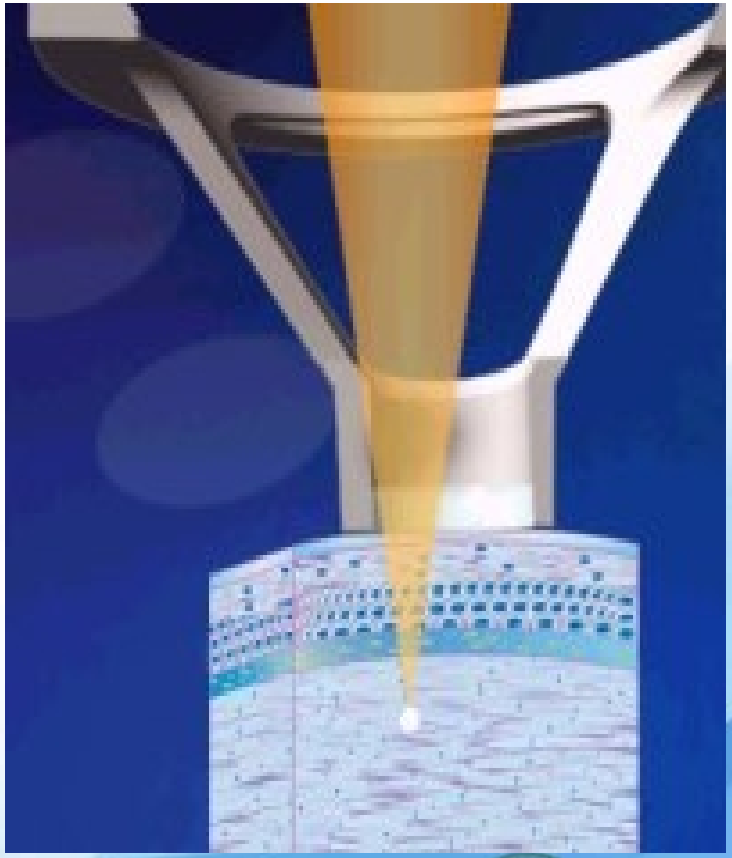
vs MK blade 160-180 u

Femto LASIK

Suction ring & Cone

Femto LASIK



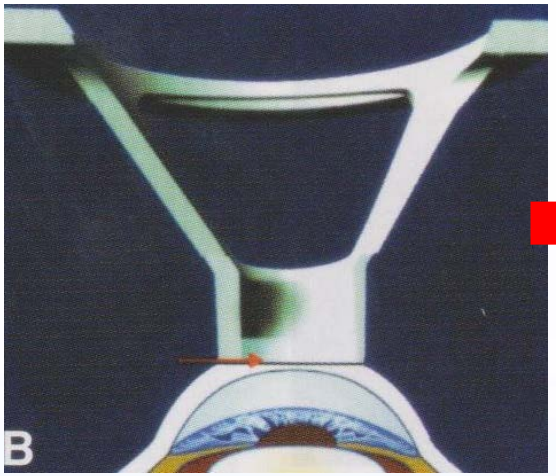


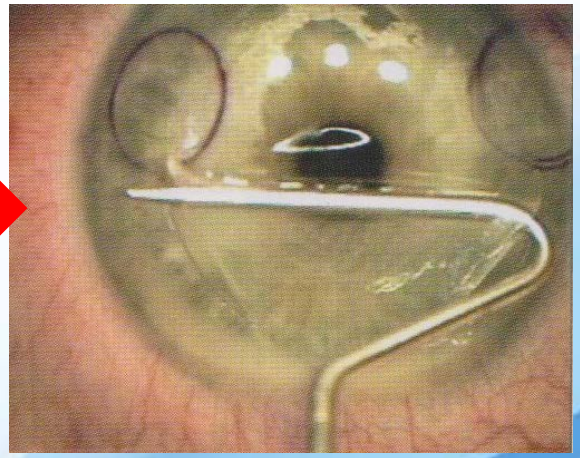
Corneal flap creation by FS laser

Suction ring (glass applanation lens)

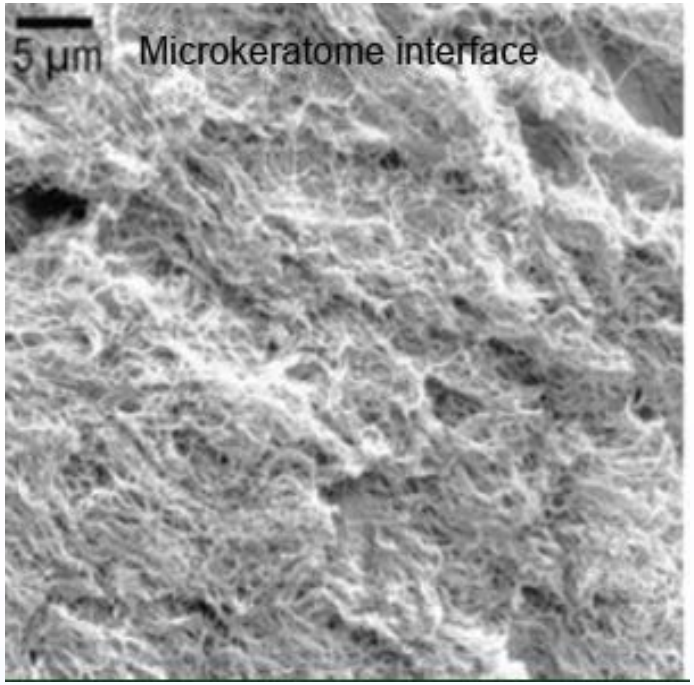
Femtosecond laser

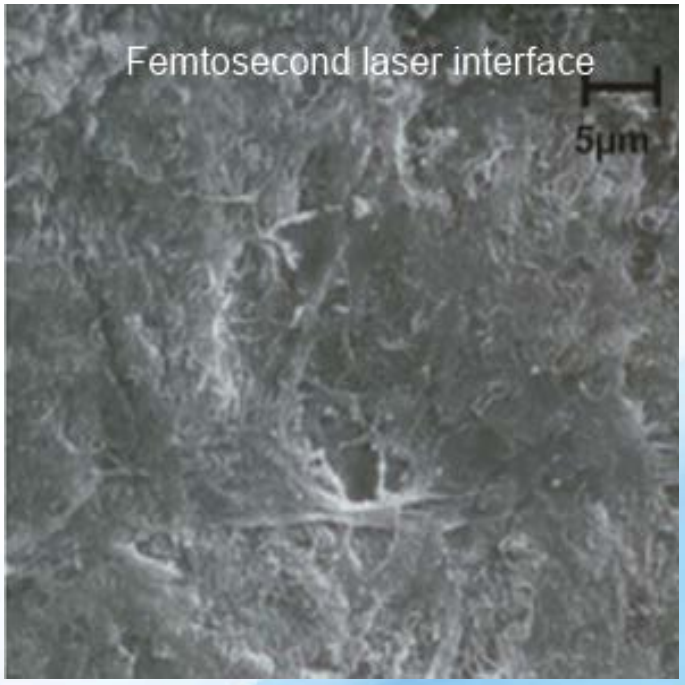
Flap is raised





MK vs FS LASIK interface

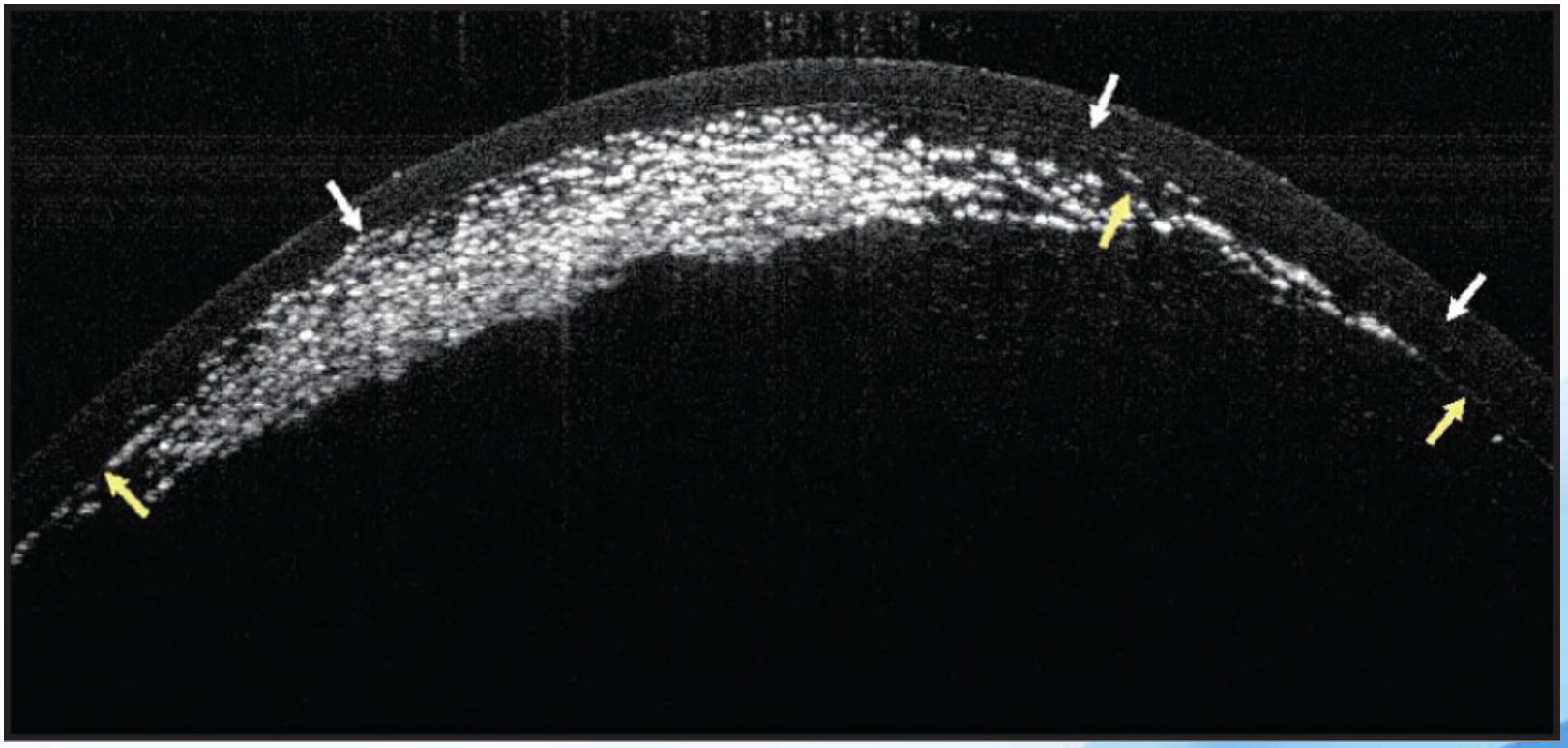




Femto LASIK vs MK LASIK

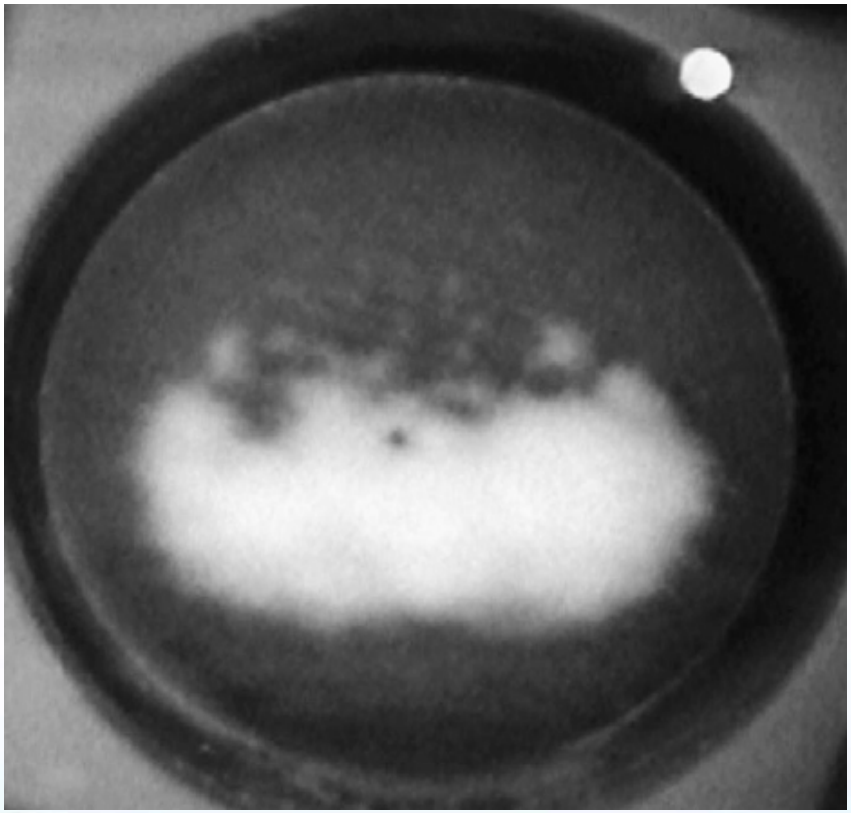
Advantages	Disadvantages
Less increase IOP	Longer suction time
Flap thinner, more control	OBL, air bubble in AC
Flap complications ↓	DLK ↑
Limbal hemorrhage ↓	Cost ↑

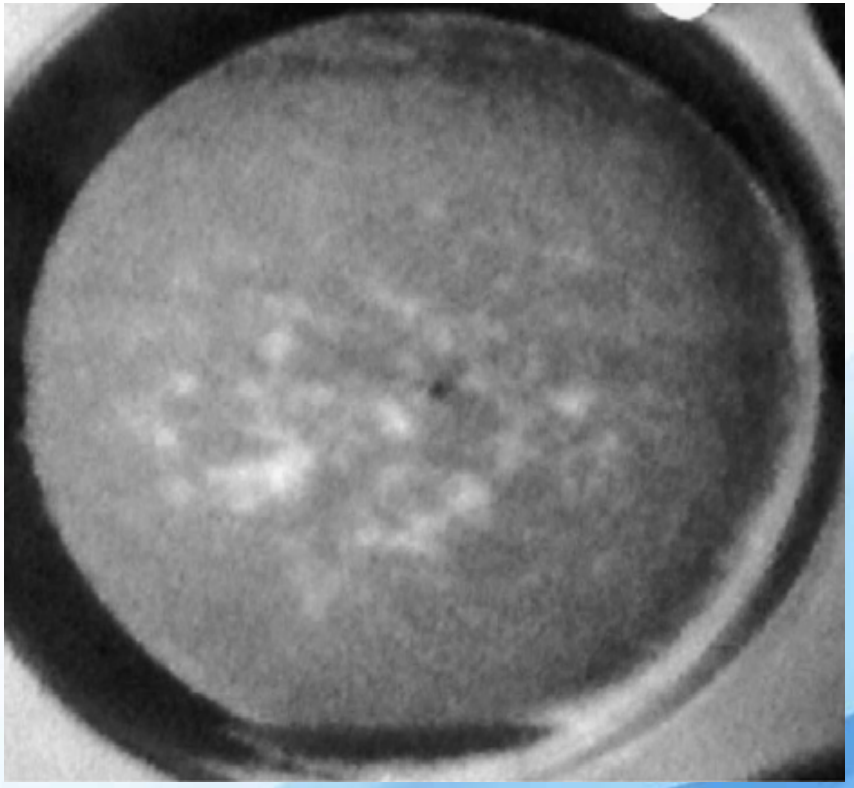
OBL by Femto LASIK



Opaque bubble layer (OBL) = $N_2 + CO_2 + H_2O$

OBL (Opaque Bubble Layer)

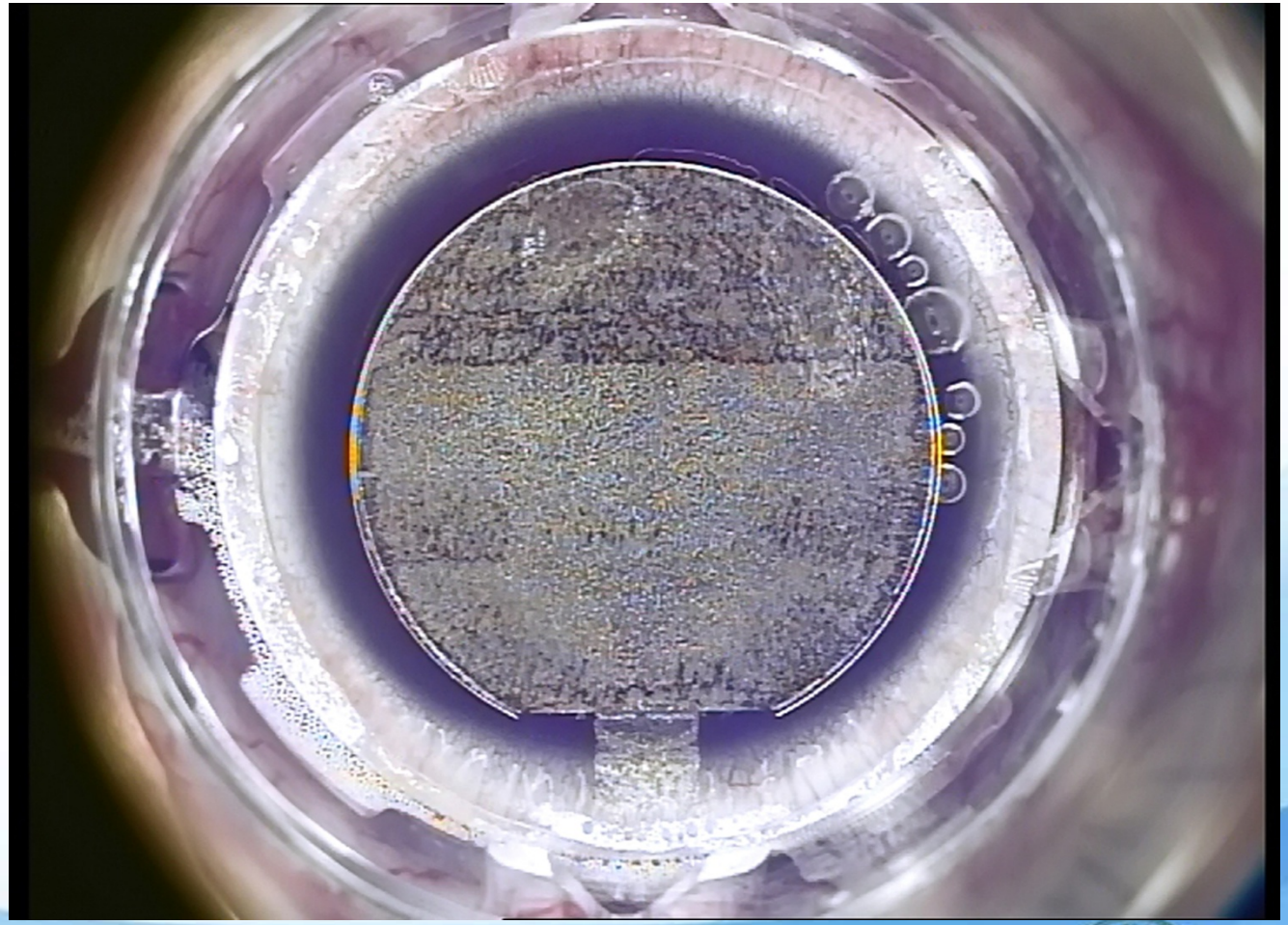




Hard OBL

Diffuse OBL

Air bubble in AC



Air bubble in AC

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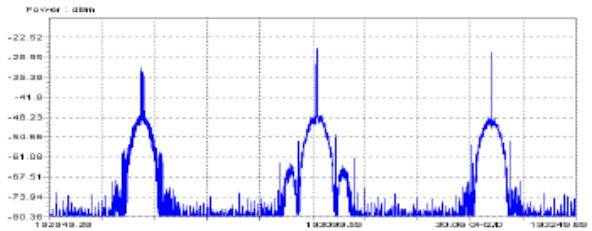

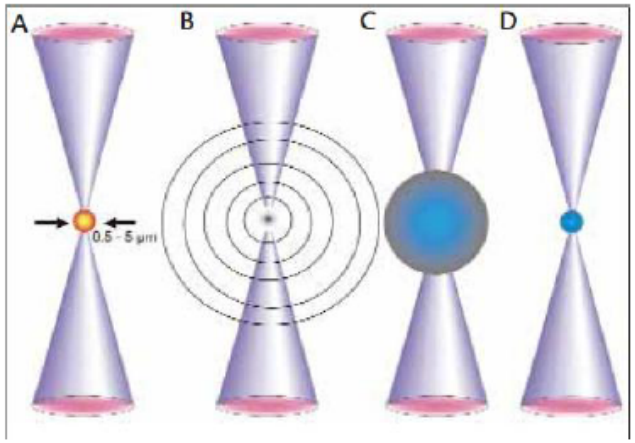

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Femto LASIK vs MK LASIK

บทความฟื้นวิชา

เฟมโตเลสิค (Femto- LASIK): เลสิคไร้ใบมีด ทางเลือกใหม่ของเลสิค

สมสงวน อัษญคุณ

ภาควิชาจักษุวิทยา คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่

เฟมโตเลสิค (Femto-LASIK) เป็นการผ่าตัดเลสิคเพื่อแก้ไขสายตาผิดปกติ โดยใช้ femtosecond (FS) laser ในการแยกชั้นกระจกตาแทนใบมีดแบบดั้งเดิม เพื่อลดข้อเสียหรือข้อจำกัดของการใช้ใบมีด บทความนี้กล่าวถึง หลักการทำงานของ FS laser ในการผ่าตัดเลสิค รวมทั้งข้อได้เปรียบและข้อจำกัดของการแยกชั้นกระจกตาด้วย FS laser เมื่อเปรียบเทียบกับใบมีดแบบดั้งเดิมพอสังเขป และการเตรียมตัวเพื่อผ่าตัดโดยวิธีเฟมโตเลสิค **เชียงใหม่เวชสาร** 2558;54(1):47-55.