

*Seminar for*

***“Young Ophthalmologists”***

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# ***LASIK Complications Etiology, Prevention and Management***

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# Background

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- ✦ LASIK is still popular method of refractive surgical correction for low-to moderate myopia and hypermetropia
- ✦ LASIK complications: \* Intraoperative  
\* Postoperative
- ✦ Prevalence of complications:
  - \* Skill-related
  - \* Minor complications: 1-2%
  - \* Major sight – threatening: 0.2-0.3%



# ***A- Intraoperative Complications***

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- + Poor exposure related complications**
- + Complications related to inadequate suction**
- + Microkeratome- Related and flap complications**
- + Laser ablation - related**



# 1- Poor Exposure Related Complications

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## + *Poor Exposure Causes:*

- \* Improper suction ring placement
- \* Inadequate suction
- \* Flap- related complications

## + *Cause:*

- \* Orbital and Facial Anatomy
- \* Small Globes
- \* Deep set eyes
- \* Prominent Brows
- \* Narrow palpebral fissure



# 1- Poor Exposure Related Complications

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## Prevention:

- ✦ Wire Lid Speculum
- ✦ Careful Draping
- ✦ Proper Head positioning
- ✦ Downward pressure over speculum
- ✦ Taping the Lashes
- ✦ Retrobulbar injection, Lateral Canthotomy:  
Not used any more
- ✦ PRK in these condition can substitute LASIK



# ***Complications Related to Inadequate Suction***

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- ⊕ Will lead to Microkeratome pass complications:  
Thin flaps, Perforated flaps, or Free caps**
  
- ⊕ Signs indicator of IOP > 65mmHg:**
  - \* Pupillary dilation**
  - \* Transient loss of patient's vision**
  - \* Deepened A/C**
  - \* Barraquer Tonometer measurement**



# ***Complications Related to Inadequate Suction***

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- ✦ **Pseudosuction:** Redundant conjunctiva or chemosis prevent adequate IOP rise
  
- ✦ **Chemosis:**
  - \* **Major:** Cancel and postpone operation for several days
  - \* **Minor:** wait 30 to 60 min. → small incision in conj. “milking” fluid away from limbus



# 3 - Microkeratome - Related & Flap Complications

## A- Thin flaps and Buttonholes

\* Incidence 0.1% to 0.2%

### Etiologic factors:

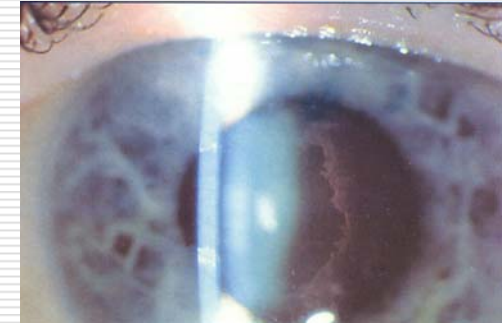
- 1- Surgeon expertise
- 2- Inadequate suction
- 3- Corneal anatomy
- 4- Microkeratome malfunction
- 5- Conjunctiva pathology
- 6- Excessive vitreous syneresis or previous vitrectomy

**Other factors:** 7- Steep corneas (>47D)

8- Irregular surface cornea (S/P PK or S/P SB)

**Most avoidable factors:** \* Microkeratome malfunction

\* Poor blade quality





# ***A- Thin flap & Button hole***

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## ***+ Buttonholed flap management:***

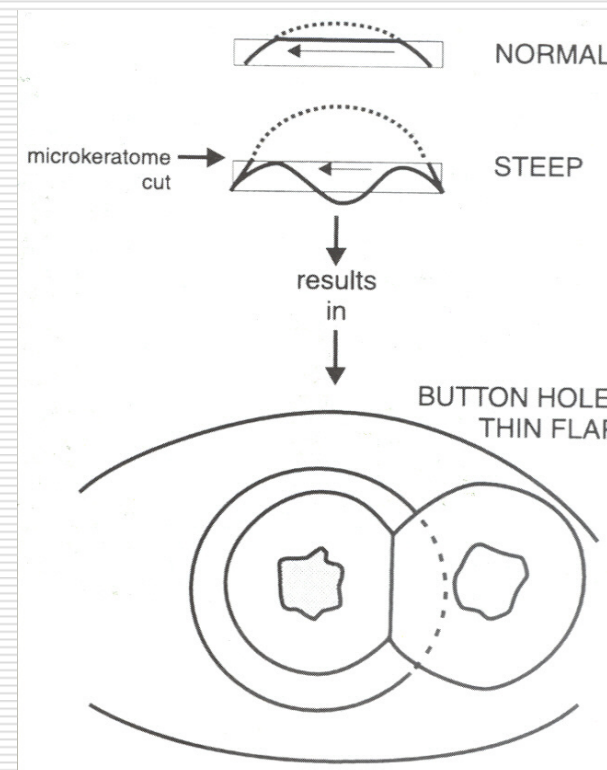
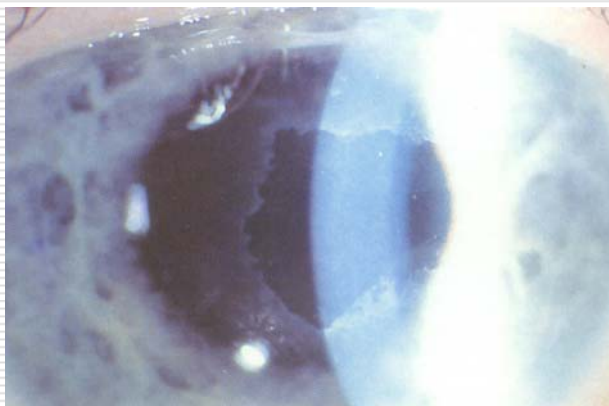
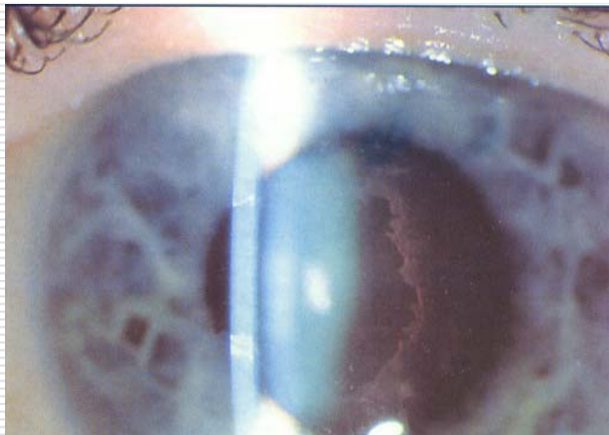
- \* Replace the flap**
- \* Abort further surgery for at least 3 mo**

## ***+ Following Risks are increased :***

- \* Epithelial Ingrowth**
- \* Irregular Astigmatism**
- \* Stromal scarring**
- \* Flap striae**



# A- Thin flap & Button hole



# ***B - Incomplete Flap***

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## ***Cause :***

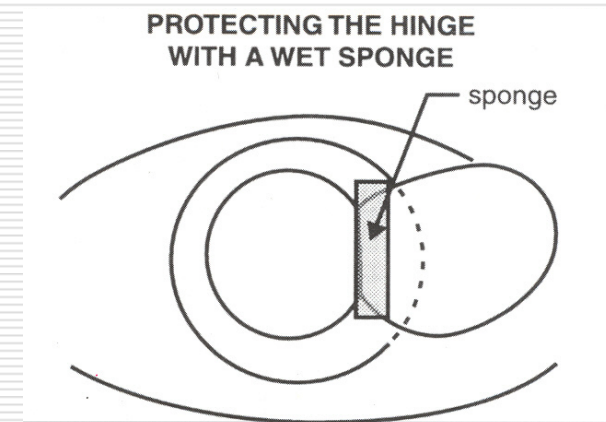
- ✦ Interference of forward motion by the speculum, eyelids, eyelash, conjunctiva, drapes
- ✦ Loss of suction, electrical power outage
- ✦ **Premature pedal release**
- ✦ Improper Microkeratome assembly
- ✦ Salt crystal deposition



# B - Incomplete Flap ... cont

## Management:

- ⊕ If hinge outside planned treatment zone:
  - \* Laser ablation
  - \* Slight decrease O.Z.
- ⊕ If hinge more central:
  - \* Reposition flap
  - \* Postpone LASIK for 3 mo → Recut
- ⊕ Note: Avoid manual completion of flap → irregular astigmatism



# C - Free Cap

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- ⊕ Free caps or 360-degree Cut Flap
- ⊕ Causes:
  - \* Mechanical: absent stopper
  - \* Anatomic: - Keratometry  $<41.0D$  (flat corneas)
    - Larger corneas ( $>14.5mm$ ) less presented in suction ring
- ⊕ Prevention: - Marking epithelium
  - Use larger diameter suction ring



# C - Free Cap... cont

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## *Management:*

- ✦ Take care of Free Cap in Antidesiccation chamber
- ✦ Perform the ablation
- ✦ Replace Cap in correct orientation
- ✦ Do not overhydrate the Cap and interface
- ✦ Prolong drying time (5min)
- ✦ Poor adhesion needs suturing
- ✦ Bandage contact lens?



# ***D - Epithelial Defects***

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## ***Predisposing factors:***

- ✦ H/O Dry Eyes
- ✦ Anterior Basement Membrane disorders
- ✦ Recurrent erosion
- ✦ Topical anesthetic overuse
- ✦ Aggressive epithelial marking
- ✦ Improper use of dry sponges

## ***Prevention:***

- ✦ Avoid excess topical anesthetic drops
- ✦ Lubricate Cornea and Microkeratome tracks
- ✦ Avoid excess eye movement



# ***D - Epithelial Defects***

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## ***Management:***

- ✦ **Smoothly put back epithelium:  
use wet cellulose sponge**
- ✦ **If repositioning not possible: remove tags**
- ✦ **Prevent introduction of epithelium under flap**
- ✦ **Severe epithelial disruption: loose fit BCL**
- ✦ **Avoid frequent NSAID or steroidal drops**





# ***E - Intraoperative Bleeding***

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- ✦ **Cause:** - Corneal vascularization due to long-term contact lens use
  
- ✦ **It is Risk factor for:**
  - \* **Surgery nuisance**
  - \* **Increased risk of DLK**
  - \* **Epithelial Ingrowth**
  - \* **Non- uniform stromal laser ablation**
  - \* **Blood staining of flap**



# ***E- Intraoperative Bleeding***

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## ***Management:***

- +** ***Preoperative:*** \* Topical Brimonidine, low potency steroids  
\* Localization of abnormal vessels
  
- +** ***Intraoperative:***
  - \* Planning the size and location of flap
  - \* Avoid blood extension into interface
  - \* Prior flap lift:- Phenylephrine vasoconstriction  
- Manual pressing vessels
  - \* Stop ablation when blood over interface
  - \* If excess irrigation: delayed flap adherence



# ***F - Decentered flap***

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## ***Causes:***

- + Suction ring Decentration**
- + Globe Torque**
- + Suction Loss**
- + Lack of patient cooperation**
- + Error in Centering the optical axis**



# ***F- Decentered flap***

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## ***Management:***

### ***+ Mild decentration:***

- \* Ablation area inside bed: laser can be performed

### ***+ : Severe decentration:***

- \* Whole area of ablation not inside the bed
- \* Do Reposition of flap!
- \* Postpone surgery for 3 to 4 mo



# ***G - Corneal perforation***

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- ⊕ Rare Catastroph with new generation of Microkeratomes
- ⊕ ***Cause:*** - Improper Depth Plate assembly
- ⊕ ***Management:***
  - \* Rapid response: stop the power and suction
  - \* Protect the perforated cornea
  - \* Send the patient to O.R for repair



# 4 - Laser Ablation- Related Complications

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## a- Central Islands

Frequency decreased due to new software, scanning beam and flying spot lasers

**Diagnosis:** \* By Topography

\* Central area ( $\geq 2.5\text{mm}$ )

\* Higher refractive power

*(>1.5D) compared to mild periphery*



## ***4 - Laser Ablation- Related Complications***

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### ***a- Central Islands***

#### ***✦ Clinical:***

- \* Halos, glare, ghosting, residual myopia**
- \* Loss of BCVA, poor visual quality**
- \* Presentation: first wk,  
persistence >6 mo about 75%**

#### ***✦ Management:***

- \* PTK, small- diameter shallow PRK**
- \* Customized ablation wavefront guided**



# 4 - Laser Ablation- Related Complications

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## ⊕ *b- Decentered Ablation*

\* Mild to moderate Decentration (up to 1mm) is tolerable

⊕ **Cause:** \*

- \* Poor patient fixation
- \* Poor Laser beam Centration

## ⊕ **Clinical:**

- \* Postoperative irregular astigmatism
- \* Loss of BCVA, UCVA
- \* Visual aberrations (i.e glare, halos, ghost images)





# C - Irregular Astigmatism

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- ✦ Irregular Astigmatism Diagnosis on Topographic map, minor amount resolves and only 1-2% become symptomatic
- ✦ **Cause:**
  - \* Decentered Ablation
  - \* Incorrect Flap Repositioning
  - \* Epithelial Ingrowth
  - \* Irregular or incomplete lamellar keratectomy
  - \* Preexisting irregular astigmatism!
- ✦ **Management:**
  - \* Rigid gas- permeable CL
  - \* Wavefront-guided Excimer treatment



# D - Over-or Under Correction

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- + Postoperative Residual Refractive error for Retreatment: **5.5-28%**
- + Causes of undercorrection:
  - \* High myopia
  - \* Difficult preop Refraction
  - \* Unstable Ametropia
  - \* Patient- specific factors
  - \* Long history of CL use
- + Overcorrection: \* Less frequent
- + Causes: \* Corneal stromal dehydration → low humidity  
\* Wrong preop Refraction



# *E - Regression*

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- Unstable Postop Refractive outcome
- Continued loss of Laser effect

- ⊕ **Cause:**
  - \* Epithelial hyperplasia
  - \* Corneal stromal Remodeling
  - \* Greater Depth of ablation
  - \* Smaller Treatment Zones

- ⊕ **Enhancement Procedure:**
  - \* Refractive outcome is not ideal
  - \* Proven stable refraction

- ⊕ **Technique:**
  - \* Re-lift the original flap up to one year
  - \* Recut a new flap



# ***B-Postoperative Complications***

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- ✦ Interface debris
- ✦ Flap displacement
- ✦ Corneal Neurotrophic Epitheliopathy
- ✦ Dry- Eye Syndrome
- ✦ Diffuse Lamellar Keratitis (DLK)
- ✦ Infectious Keratitis
- ✦ Epithelial Ingrowth
- ✦ Flap fold and striae
- ✦ Interface Haze
- ✦ Iatrogenic or Progressive Ectasia



# 1 - Interface Debris

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## ✦ *Debris types:*

- \* Non- organic: Talc, Lint, metal particles, sponge fibers
- \* Organic: mucus, oil droplets (in tear)

## ✦ *Indication for removal:*

- \* Immediate postop Exam
- \* Inflammation
- \* Irregular astigmatism
- \* Loss of BCVA or UCVA



# 2 - Flap Displacement

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- ✦ Immediate postop Complication:24-48hr
- ✦ Incidence 0.85% to 2%

## Cause:

- \* **Mechanical:** Eye rubbing, dry eyes, eye-drop tip
- \* Poor Endothelial cell function
- \* Excessive Intraoperative Flap Hydration
- \* Sport or accidental, self- induced trauma



# 2- Flap displacement

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## ⊕ *Prevention:*

- \* Drying time 2 min at conclusion of LASIK
- \* Well- lubricated corneal surface
- \* Postoperative Exam
- \* Eye shield during night time

## ⊕ *Management:*

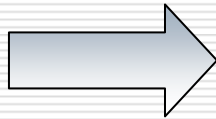
- \* Lifting the affected area, cleaning the epithelium or debris → Relocating the flap
- \* Sutures may be needed if recurrent



# 3- Corneal Neurotrophic Epitheliopathy and Dry- Eye syndrome

Trigeminal nerve → Ophthalmic div. → Long Ciliary nerves

LASIK cut



Stromal nerve roots  
(Ant. 1/3 corneal stroma)

Corneal  
sensation

Emerging at 3 & 9 o'clock meridia

Central Corneal Branches

Basal epithelial nerve plexus ← Dense Subepithelial plexus

Corneal nerve cut → decreased blink reflex, tear flow, local Neuromodulatory factors





# Post-LASIK Dry Eyes

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✦ **Incidence:** ~4%

✦ **Duration:** 3 - 6 mo

✦ **Related Risk factors:**

- \* flap thickness, flap diameter, depth of stromal ablation
- \* Nasal hinge better than superior
- \* PRK shorter recovery
- \* Femtosecond laser cut has more rapid Reinnervation
- \* Past history of dry eye: worse

✦ **Treatment:**

- \* Reassurance
- \* Aggressive topical lubrication
- \* Punctal occlusion if needed



## 4- Diffuse Lamellar Keratitis

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### ✦ **Synonyms:**

- \* Sands of Sahara, SOS, Post-LASIK interface keratitis
- \* Noninfectious diffuse inflammation at the flap interface

### ✦ **Onset:** 1-7 day

Incidence: 0.75% to 58.3%

### ✦ **Etiology:**

- \* Immune response to Endogenous and Exogenous factors
- \* Interface debris, oil on Mikrokeratome, talc powder
- \* Bacterial exotoxins and endotoxins:
  - Lipopolysaccharide
  - Peptidoglycan
- \* Detergents, RBC, Betadine



# *Symptoms of DLK*

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- ✦ From No symptom, to severe photophobia, decreased vision, pain, redness, tearing
- ✦ **Grading system: Linebarger-Lindstrom**
  - \* **Grade I:** peripheral WBC infiltration, No change in VA
  - \* **Grade II:** WBC infiltration cross visual axis  
minimal symptoms, No decrease in BCVA
  - \* **Grade III:** More dense accumulation of WBC  
Decreased BCVA, haze, photophobia
  - \* **Grade IV:** Scarring, edema, large folds  
Decreased BCVA, hyperopic shift, symptomatic



# Symptoms of DLK

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## ✦ Treatment

**Grade I :** Topical steroid q1-2 hr

**Grade II:** Topical steroid q1-2 hr

Oral steroids 60-80 mg qd

**Grade III:** + Flap lifting and Steroids irrigation

**Grade IV:** Above medications +Permanent scarring no response to aggressive treat



# 5 - Infectious Keratitis

✦ Uncommon(1/1000 to 1/5000)

✦ **Risk factors:**

- \* Disruption of normal corneal structure
- \* Loss of normal epithelial physiology
- \* Presence of blepharitis
- \* Long-term use of topical steroids



✦ **Clinical Picture:**

- \* White interface infiltrate, , overlying epithelial defect  
stromal edema, AC reaction, Hypopyon
- \* Satellite lesions: Consider Fungal Keratitis



# 5-Infectious keratitis

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## ✦ *Atypical Mycobacteria:*

- \* Most common pathogen, M.Chelonae
- \* Multiply in water, soil foodstuff
- \* **Treatment**; aggressive: Amikacin, Clarithromycin  
Imipenem, Ciprofloxacin, steroids

## ✦ *Staph. aureus, second most common*

- \* Risk factors: blepharitis, Meibomian gland disease
- \* Better outcome and response to therapy
- \* 35% of S. aureus are resistant to 2<sup>nd</sup> and 3<sup>rd</sup> generation fluoroquinolone
- \* Gatifloxacin, Moxifloxacin: effective



# 5- Infectious Keratitis

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## ✦ *Culture taking:*

- \* Flap lifting → also for antibiotic irrigation of flap and interface

## ✦ *Treatment:*

- \* Frequent dose fluoroquinolone fortified Vancomycin or Cefazolin
- \* Close follow up

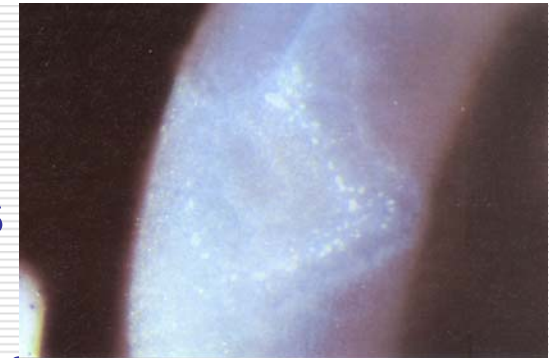


# 6- Epithelial Ingrowth

- ✦ Rare
- ✦ **Presentation:** Days to months, mostly within 2 mo

- ✦ **Risk factors:**

- \* Flap complications
- \* Epithelial defects
- \* Postop. Dislodged flap
- \* Large-diameter hyperopic treatment
- \* Interface- debris, Inflammation, blood
- \* Poor flap adhesion





## 6 - Epithelial Ingrowth ... cont

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- ✦ **Course:** \* Unpredictable
  - \* 90% remain stable or decreases in size
- ✦ Rare, expansion of Epithelial Ingrowth, irregular astigmatism
- ✦ Loss of BCVA, Keratolysis, Overlying stromal melt
- ✦ **Prevention:** \* Contact lens use: in flap complications, CED near flap margin
  - \* Prevention of ablation beyond bed
  - \* Clear epithelial debris and tags



# 6 - Epithelial Ingrowth ... cont

## ✦ *Indications for treatment:*

- \* Visually significant Ingrowth
- \* Progression across visual axis
- \* Induction of irregular astigmatism
- \* Size > 2mm → higher risk of Keratolysis



## ✦ *Recurrence after first debridement: 20-40%*

- ✦ Repeated lifting with epithelial debridement + interrupted 10/0 nylon at fistula



# 7- Flap fold, Striae, or Microstriae

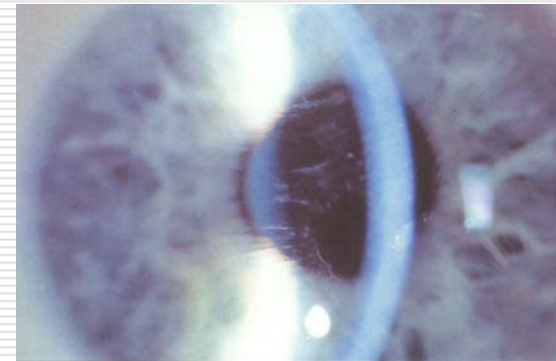
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⊕ **Flap Wrinkles (general term)**= flap fold>striae>Microstriae

- ⊕ **Etiology:**
- \* Mechanical: eye rubbing, dry eye, trauma
  - \* Anatomic:
    - after ablation flap surface area>stromal bed

risk is higher in High Myopia correction

- ⊕ **Diagnosis:**
- \* Best seen in retroillumination
  - \* Fluorescein staining detects wrinkles: **Negative staining are peaks**



# 7- Flap Wrinkles

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- ✦ **Treatment:** \* Is the same as flap displacement
- ✦ **Indication:** \* Central wrinkles reduces BCVA  
\* Patient's related symptoms
- ✦ **Technique:** \* Flap lift and refloat  
\* Stretching the flap with dry sponge 90 to wrinkle direction  
\* Flap Hydration with Hypotonic Saline  
\* Epithelial debridement to release folds  
\* Suturing flap  
\* Laser Ablation over flap Wrinkles



# 8 - Interface Haze

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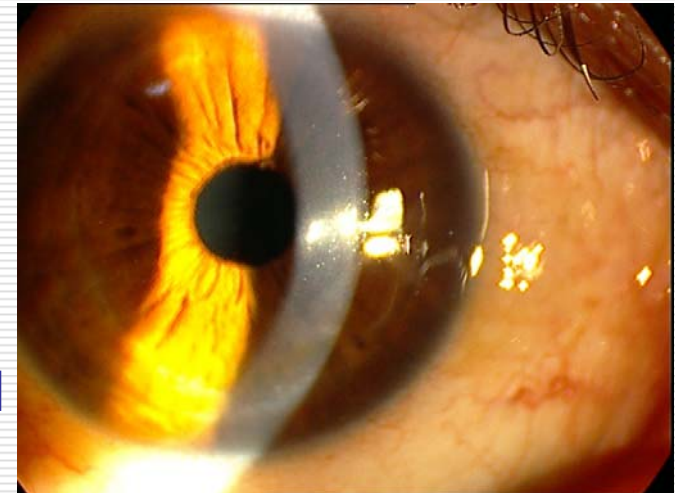
- ⊕ Haze is much less common in LASIK than PRK
- ⊕ **Risk factors:** \* Correction of High refractive errors  
\* LASIK retreatment after PRK
- ⊕ Usually responds well with a course of steroid treatment



## 9 - Iatrogenic or Progressive Keratectasia

### ⊕ **Cause:**

- \* Unknown
- \* Post-LASIK alterations in corneal integrity
- \* Biomechanical changes in Cornea as a result of laser-induced Proteolysis



- ### ⊕ **Clinical Picture:**
- \* Progressive myopic shift
  - \* Increase in astigmatism
  - \* Mono ocular diplopia or visual distortions
  - \* Loss of UCVA and BCVA (with spectacles)

- ### ⊕ **Incidence:** 0.04% → seems underestimation



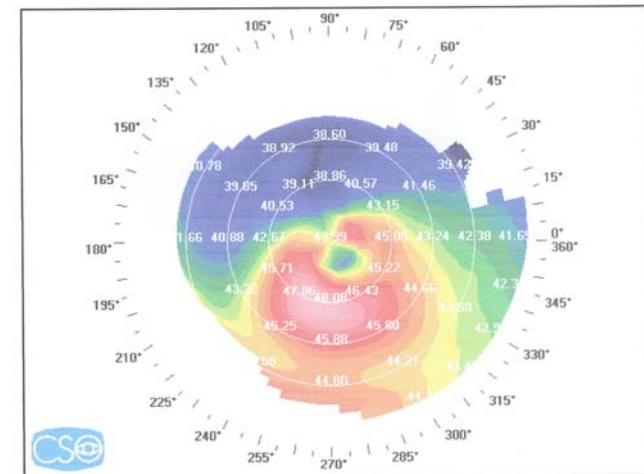
## 9 - Keratectasia... cont.

### ✦ Risk factors:

- \* Preop high myopia – increased depth of ablation
- \* Keratoconus
- \* Forme Fruste Keratoconus
- \* Unknown
- \* Remained stromal bed <250 $\mu$

### ✦ Remained Stromal Bed:

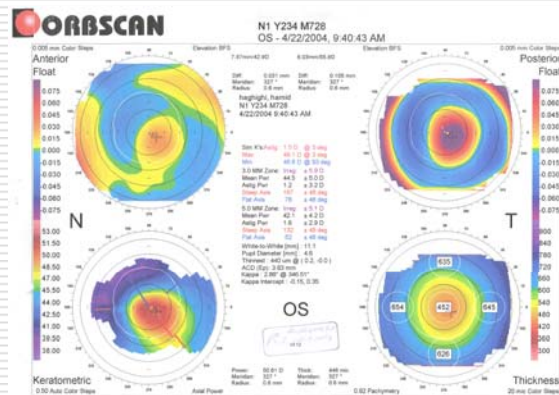
- \* At least 250 $\mu$  (some reports even 300  $\mu$ )
- \* Target > 50% preop corneal thickness
- \* Inaccurate, due to inaccurate flap thickness



# 9- Keratectasia... cont

## + Management:

- \* Prevention is more simple
- \* **Red flag signs:** - If preop BCVA uncorrected to 20/20
  - Irregular astigmatism
  - Inferior steepening
  - Unstable preop refraction
  - Progressive astigmatism and myopic shift
  - Remained Bed < 250  $\mu$



- ## + Treatment:
- \* Spectacles, Soft Contact Lens, RGP-CL's
  - \* PK in 30% of advanced cases





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***Thank You for Your  
Kind Attention!!***



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