

Seminar for

“Young Ophthalmologists”

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

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Background

- ✦ 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

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



1- Poor Exposure Related Complications

+ *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

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

- ⊕ 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

- ✦ **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:

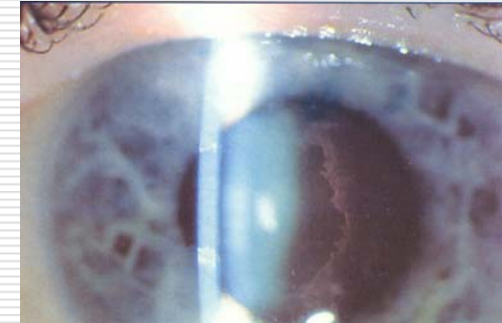
- 1- Surgeon expertise
- 2- Inadequate suction
- 3- Corneal anatomy
- 4- Microkeratome malfunction
- 5- Conjunctiva pathology
- 6- Excessive vitreous syneresis or previous vitrectomy

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

+ Buttonholed flap management:

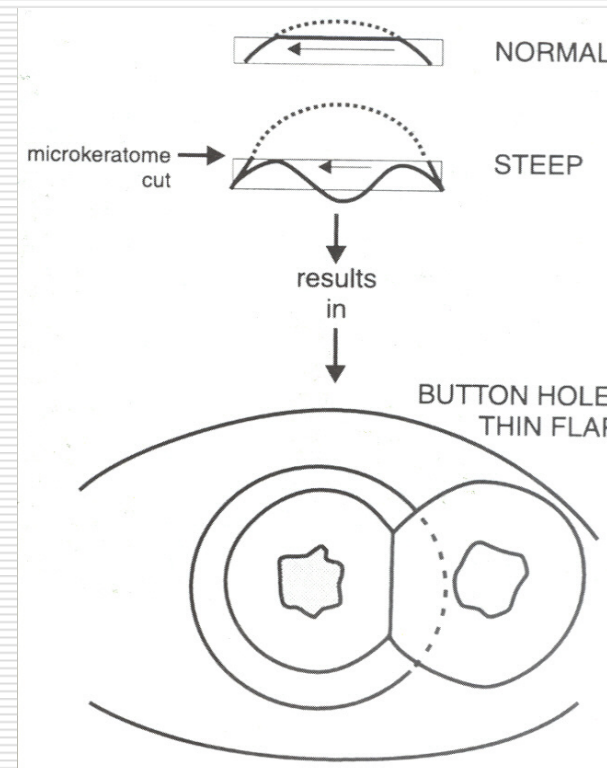
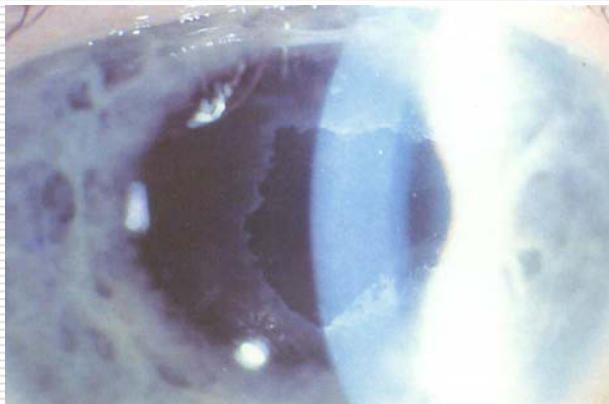
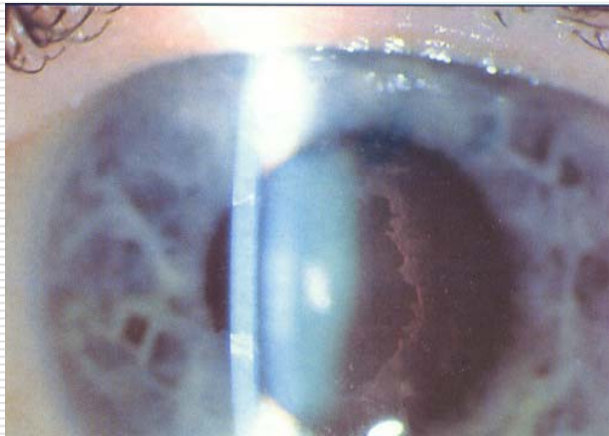
- * Replace the flap**
- * Abort further surgery for at least 3 mo**

+ Following Risks are increased :

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



A- Thin flap & Button hole



B - Incomplete Flap

Cause :

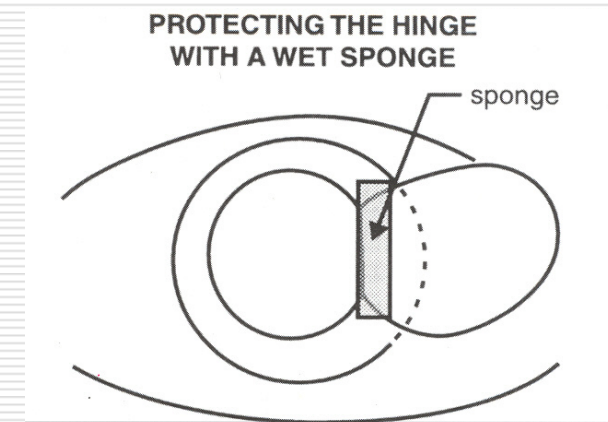
- ✦ Interference of forward motion by the speculum, eyelids, eyelash, conjunctiva, drapes
- ✦ Loss of suction, electrical power outage
- ✦ **Premature pedal release**
- ✦ Improper Microkeratome assembly
- ✦ Salt crystal deposition



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

- ✦ 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

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

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

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

- ✦ **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

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

Causes:

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



F- Decentered flap

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

- ⊕ 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

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

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

⊕ *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

- ✦ 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

- + 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

- 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

- ✦ 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

✦ *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

- ✦ 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

⊕ *Prevention:*

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

⊕ *Management:*

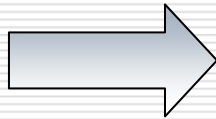
- * Lifting the affected area, cleaning the epithelium or debris → Relocating the flap
- * Sutures may be needed if recurrent



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

✦ **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

✦ **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

- ✦ 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

✦ 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

✦ *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 2nd and 3rd generation fluoroquinolone
- * Gatifloxacin, Moxifloxacin: effective



5- Infectious Keratitis

✦ *Culture taking:*

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

✦ *Treatment:*

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

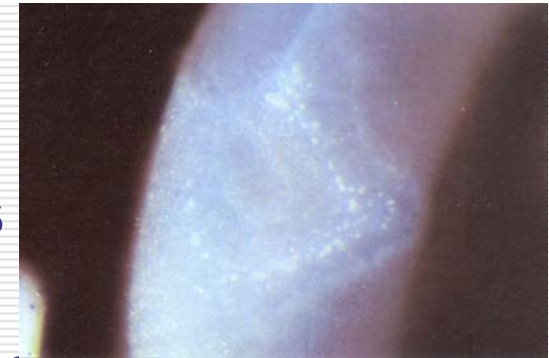


6- Epithelial Ingrowth

- ✦ 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

- ✦ **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



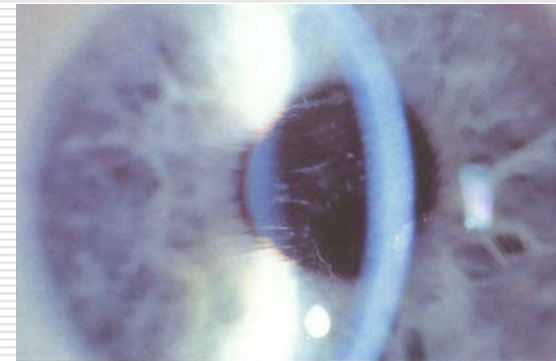
7- Flap fold, Striae, or Microstriae

⊕ **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

- ✦ **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

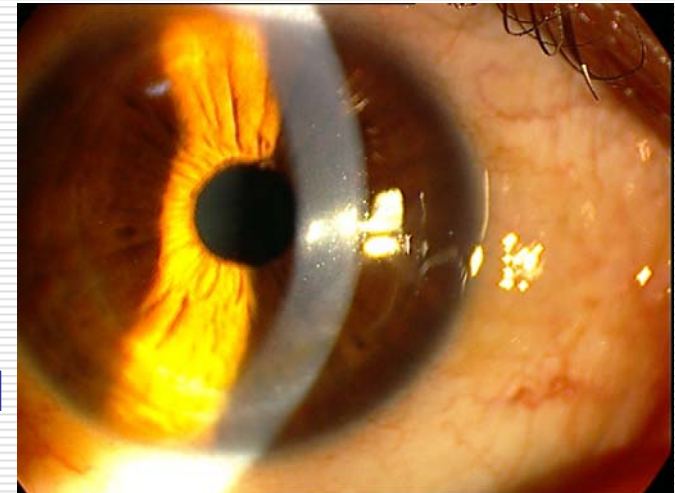
- ⊕ Haze is much less common in LASIK than PRK
- ⊕ **Risk factors:** * Correction of High refractive errors
* LASIK retreatment after PRK
- ⊕ Usually responds well with a course of steroid treatment



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



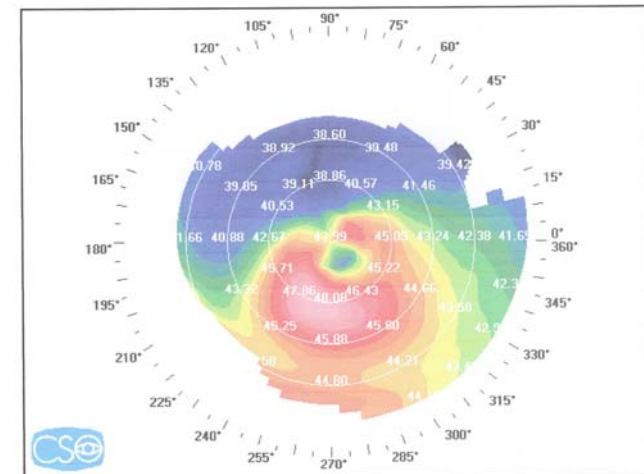
9 - Keratectasia... cont.

✦ Risk factors:

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

✦ Remained Stromal Bed:

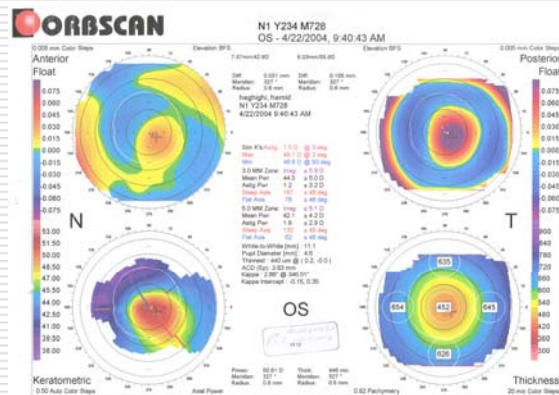
- * At least 250 μ (some reports even 300 μ)
- * Target > 50% preop corneal thickness
- * Inaccurate, due to inaccurate flap thickness



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 μ



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



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



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