LASIK Complications
Etiology, Prevention and Management

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Background

- LASIK is still a 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

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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
**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

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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 Catastrophe 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 ($\geq 2.5$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, persistance>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 Epitheliolpathy and Dry-Eye syndrome

- Trigeminal nerve → Ophthalmic div. → Long Ciliary nerves

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

Emerging at 3 & 9 o’clock meridia

Central Corneal Branches

Basal epithelial nerve plexus ← Dense Subepithelial plexus

Corneal sensation

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

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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 2\textsuperscript{nd} and 3\textsuperscript{rd} 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
Indications for treatment:

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

Recurrence after first debridment: 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

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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 µ

Treatment: * Spectacles, Soft Contact Lens, RGP-CL’s
* PK in 30% of advanced cases
Thank You for Your Kind Attention!!