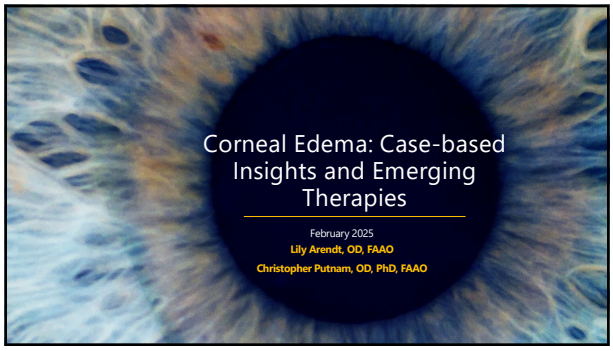

Corneal Edema: Case-based Insights and Emerging Therapies
February 2025
Lily Arendt, OD, FAAO
Christopher Putnam, OD, PhD, FAAO

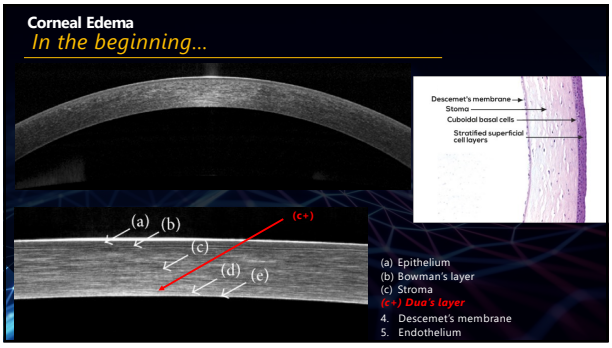
1


Financial Disclosures
Dr. Arendt
• Consultant - RxSight
Dr. Putnam
• Consultant - MacuHealth, LLC

2


Overview
• Etiology and physiology of corneal edema
• Clinically-useful, peer-reviewed tips for diagnosing edematous conditions through multiple, unique cases
• Current and emerging treatments

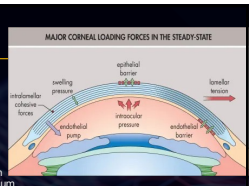
3


Corneal Edema
In the beginning...
Descemet's membrane
Stroma
Cuboidal basal cells
Stratified superficial cell layers
(a)
(b)
(c)
(d)
(e)
(c+)
(a) Epithelium
(b) Bowman's layer
(c) Stroma
(c+) Dua's layer
4. Descemet's membrane
5. Endothelium

4

Corneal Edema
In the beginning…

- **Physiology**
  - Cornea maintains ~78% hydration level
- **Primary Factors**
  - **Stromal pressure (SP)**
    - Normal stromal pressure = 55mmHg
    - Imbibition pressure (IP) exerted by drawing fluid into cornea
    - *Intraocular pressure (IOP) = SP + IP*
  - **Barrier function**
    - Epithelium offers *2X* hydrostatic resistance compared to endothelium
    - Electrolyte resistance is *200X* higher in the epithelium than endothelium
  - **Endothelial pump**
    - Endothelial permeability increases if endothelial cell density *<2000 cells/mm²*
    - Compensatory pump mechanisms maintain dehydrated state until *~500cells/mm²*
  - **Tear evaporation**
    - Normal evaporation (2.5ml/cm²/hour) creates hypertonic state & ~5% thinner cornea
      - Exhibited in diurnal BCVA variations in patients with the early Fuchs' dystrophy
  - **Intraocular Pressure**
    - IOP >50mm Hg exceeds stromal pressure creating epithelial edema
      - *High IOP and normal SP = acute glaucoma*
      - *Normal IOP and low SP = endothelial dystrophy*



5

Corneal Edema
Clinical Imaging Capabilities

AS-OCT

- *Categorized by λ*
  - *Dedicated 1310nm*
    - Zeiss Visante (FDA-approval 2005)
    - Heidelberg SL-OCT (FDA-approval 2006)
    - Tomey CASIA
  - *Converted retinal imaging 830-850nm*
    - Optovue RTvue and Optovue
    - Zeiss Cirrus
    - Heidelberg Spectralis

	Time-domain AS-OCT	Spectral-domain based AS-OCT	Swept-source AS-OCT
Central wavelength	1310 nm	830 nm	1310 nm
Axial resolution	>15 µm	<10 µm	10 µm
Imaging depth range	6-7 mm	2-3 mm	6 mm
Line-scan rate	2 kHz/200 Hz	20-40 kHz	30 kHz

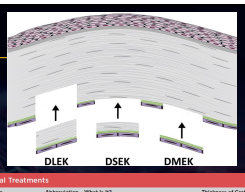
- **Clinical Utility**
  - Pterygia / Pinguecula / Scleromacia
  - CRS and *Ectasia*
  - Cataract surgery (cornea + lens + biometry)
  - *Corneal dystrophies*
  - *Keratitis*
  - Tumors
  - Glaucoma (Angle assessment / LPI / Bleb / Tube)

6

Corneal Edema
Surgical Options

TABLE 2 Contemporary Keratectomy and Keratoplasty Procedures

Acronym	Procedure
ALK (ALTK)	Anterior lamellar keratoplasty (therapeutic)
DALK	Deep anterior lamellar keratoplasty
DLEK	Deep lamellar endothelial keratoplasty
DMEK	Descemet's membrane endothelial keratoplasty
DSEK (DSAEK)	Descemet's stripping (automated) endothelial keratoplasty
DSO/DWEK	Descemet's stripping only/Descemet's stripping without endothelial keratoplasty
EK	Endothelial keratoplasty
FALK	Femtosecond anterior lamellar keratoplasty
FLAK/FLEK	Femtosecond laser assisted (enabled) keratoplasty
PD-DALK	Predescemetic deep anterior lamellar keratoplasty
PDEK	Predescemet's endothelial keratoplasty
PKP/PK	Penetrating keratoplasty
PRK	Photorefractive keratectomy
PTK	Phototherapeutic keratectomy
SK	Superficial keratectomy



Surgical Treatments

Procedure	Abbreviation	What is It?	Thickness of Graft Tissue
Penetrating keratoplasty	PK	Full-thickness replacement of the patient's cornea with a donor corneal graft	Full thickness
Descemet stripping automated endothelial keratoplasty	DSAEK	Selective removal of the patient's Descemet membrane and endothelium followed by transplantation of a donor graft composed of corneal stroma (variable thickness), Descemet membrane, and endothelium	100-200 µm
Ultrathin Descemet stripping automated endothelial keratoplasty	UT-DSAEK		50-100 µm
Nanothin Descemet stripping automated endothelial keratoplasty	NT-DSAEK		≤50 µm
Descemet membrane endothelial keratoplasty	DMEK	Selective removal of the patient's Descemet membrane and endothelium followed by transplantation of a donor graft composed of Descemet membrane and endothelium	10-15 µm
Descemetorrhexis without endothelial keratoplasty/Descemet stripping only	DWEK/DSO	Selective removal of the patient's Descemet membrane and endothelium; no subsequent donor graft transplantation	No graft tissue

7

Corneal Edema
Case 1 – 74yo Caucasian female

CC/HPI

- CC: blurred vision in both eyes that has been worsening over the last 2 years
- HPI: (+) glare (-)pain, (-) irritation

Other pertinent history

- Optometrist has diagnosed her with mild cataracts OU

Current mediations

- Lisinopril 10mg po qday

8

Corneal Edema

Case 1 – 74yo Caucasian female

scDVA

- **OD: 20/150 PH 20/40**
- **OS: 20/150 PH 20/50**
- Spectacles
  - OD: +2.75-1.00x108
  - OS: +2.50-1.00x068

Entrance testing

- Normal
  - Pupils
  - EOMs
  - CVF

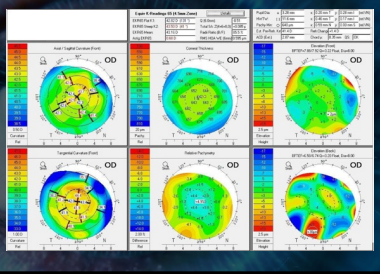
IOP

- iCare
  - OD: 6mmHg
  - OS: 8mmHg

9

Corneal Edema

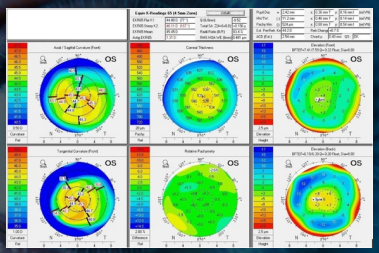
Case 1 – 74yo Caucasian female



10

Corneal Edema

Case 1 – 74yo Caucasian female



11

Corneal Edema

Case 1 – 74yo Caucasian female

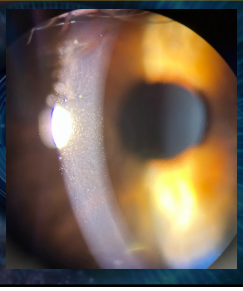
Slit lamp exam

- Normal adnexa, lashes OU
  - (+) dermatochalasis RUL/LUL
  - (+) lash collarettes OU
- Cornea
  - **3-4+ guttata OU** (-) obvious edema
  - (-) epi defect or lesion
- AC deep and quiet OU
- 1+ NS OU

12

Corneal Edema

Case 1 – 74yo Caucasian female



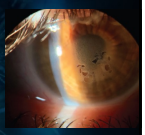
13

Corneal Edema

Case 1 – Fuchs Endothelial Corneal Dystrophy

What is it?
- Slowly progressive, non-inflammatory, bilateral corneal endothelial dystrophy
- Characterized by abnormal corneal endothelial cell size and shape, decreased cell density, Descemet membrane thickening, and guttata formation
- Onset 30s to late 50s
- Primary indication for keratoplasty worldwide[1]

Clinical features
- Slit lamp biomicroscopy
  - Guttata centrally vs peripherally
  - Stromal edema, Descemet's folds
  - Microcystic edema, epithelial bullae in severe cases
- Specular Microscopy

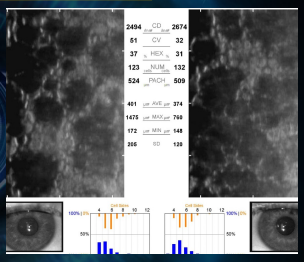


14

Corneal Edema

Case 1 – Fuchs Endothelial Corneal Dystrophy

Specular microscopy
- **Allows for observation and measurement of guttae**
- **Endothelial cell density**
  - **Start with 4000-5000 cells/mm² at birth**
- **Uniformity of cells**
  - **Polymegethism = cell size**
  - **Pleomorphism = cell shape**



15

Corneal Edema

Case 1 – Fuchs Endothelial Corneal Dystrophy

Patient symptoms
- Decrease in vision quality
  - Corneal edema 2° to gradual failure of the endothelial pumps
  - ↓Contrast sensitivity and ↑HOA
- Blurred vision or increased glare in the AM
  - Nocturnal corneal swelling takes longer to resolve
- ***4th decade (early signs) → 5th decade (early symptoms) → 6th decade (signs + symptoms)***

Prevalence[1]
- US population: 3.9-6.6%
- More common in Caucasians
- 3 : 1 Female : Male
- Inherited AD pattern

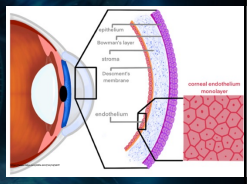
16

Corneal Edema

Case 1 – Fuchs Endothelial Corneal Dystrophy

Endothelium

- Innermost layer of cornea forming hexagonal cell monolayer
- Highly metabolically active
- **Maintains the constant hydration state of the cornea (aka: transparency)**
  - Maintains relative stromal dehydration through intercellular tight junctions and Na^+/K^+ ATPase pumps
- Gradual decrease in density over time
  - ~5000 cells/mm² at birth
  - 0.4% to 0.6% rate of decrease per year
  - Late adulthood: 2000-3000 cells/mm²



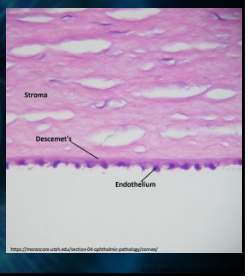
17

Corneal Edema

Case 1 – Fuchs Endothelial Corneal Dystrophy

Descemet membrane (DM)

- Secreted by endothelial cells
  - Basement membrane comprising extracellular matrix
- Located between the posterior stroma and single layer of endothelial cells
- 6-10µm thick in adulthood
- Porous structure allows for exchange between stroma and endothelium
- Helps endothelial cells maintain dehydration of the stroma



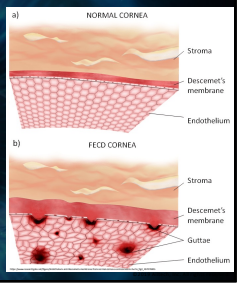
18

Corneal Edema

Case 1 – Fuchs Endothelial Corneal Dystrophy

Pathogenesis

- Progressive decline in endothelial cells causing polymegathism and pleomorphism
  - Central CECs are affected first, then peripheral
- Homeostasis between Descemet and ECM is disrupted
  - Formation of guttae and disorganized ECM collagen fibrils
- As endothelial cell density decreases, pumps are unable to maintain corneas state of dehydration
  - ***Loss of corneal transparency***
  - ***Stromal edema***
  - ***Epithelial bullae***

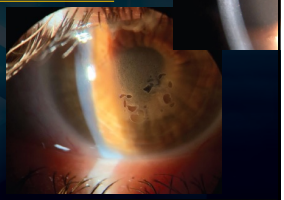


19

Corneal Edema - Take Home Points

Fuchs Endothelial Corneal Dystrophy

- **Diagnosis**
  - **Central guttae**
  - **Microcystic edema**
  - **Vertical striae**
  - **Descemet's folds**
  - **Bullae**
- **Medical Management**
  - **Topical hypertonic solution / ointment**
  - **BCL (bullae erosion management)**
  - ***Rho-kinase inhibitors***
- **Surgical Management**
  - **Descemet membrane endothelial keratoplasty (DMEK) (1st line)**
  - **Descemet stripping endothelial keratoplasty (DSEK) (2nd line)**



20

Corneal Edema - Take Home Points

Rho-kinase Inhibitor (Netarsudil 0.02%)

FDA approved for:
- Reduction of elevated IOP in patients with POAG or OHTN

MOA: *Believed to reduce IOP by increasing the outflow of aqueous humor through the TM*

Off-label uses identified in the literature:
- DME management
- ***Corneal endothelial dysfunction (Fuchs dystrophy)***

21

Corneal Edema - Take Home Points

Rho-kinase Inhibitor (Netarsudil 0.02%)

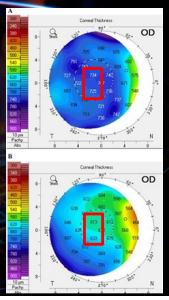
Case Series: Novel Utilization of Rho-Kinase Inhibitor for the Treatment of Corneal Edema

Cornea (2021) 40(1): 116-120

Methods
- 4 patients presenting with visual complaints from corneal edema secondary to endothelial cell dysfunction were treated with topical netarsudil one drop daily in the affected eye

Results
- Corneal clearance observed in:
  - ***Peripheral edema in iridocorneal endothelial syndrome after 4-week use***
  - ***Edema in early penetrating keratoplasty graft failure after 2-week use***
  - ***Edema in chronic penetrating keratoplasty graft failure after 4-week use***
  - ***Corneal clearance was not observed in edema due to pseudophakic bullous keratopathy from previous complicated intraocular lens exchange surgery with placement of an anterior chamber intraocular lens after the use of netarsudil for 12 weeks***

Conclusions
- Addition of topical rho-kinase inhibitor (netarsudil) can result in corneal clearance in variety of cases of endothelial cell dysfunction
  - ***Use of ROCK inhibitor eye drops as alternative to graft surgery for certain forms of corneal endothelial disease***



22

Corneal Edema

Case 2 – 41yo Caucasian male

CC/HPI	Other pertinent history	Current mediations
• CC: **blurred vision centrally in left eye x 6 months**, good vision right eye • HPI: (-) pain, discomfort, or light sensitivity	• This happened 9 months ago and resolved with steroid gtts, ung, and oral antiviral • Symptoms improved over 4 weeks, then blur occurred after stopping meds 1 month later • (+) shingles on orbital skin 3 years prior	• PFATs prn OU

23

Corneal Edema

Case 2 – 41yo Caucasian male

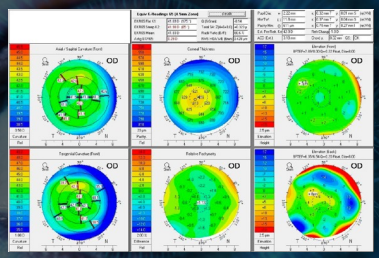
ccDVA	Entrance testing	IOP

• OD: 20/20
• OS: 20/50^{-1} PH 20/30^{-1}
• Spectacles: 1 month
  • OD: +0.50-0.25x080
  • OS: +1.00-1.25x085
	• Normal
	  • Pupils
	  • EOMs
	  • CVF
		• GAT
		  • OD: 16mmHg
		  • OS: 18mmHg

24

Corneal Edema

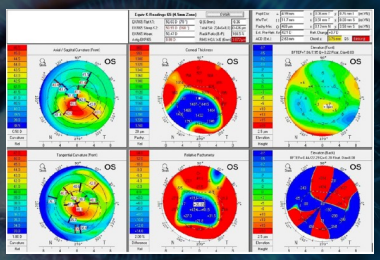
Case 2 – 41yo Caucasian male



25

Corneal Edema

Case 2 – 41yo Caucasian male



26

Corneal Edema

Case 2 – 41yo Caucasian male

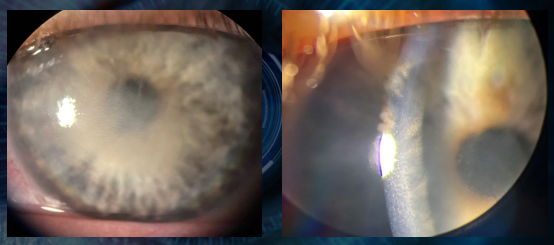
Slit lamp exam

- Normal adnexa, lids, lashes OU (-) periorbital lesions
- OD: normal
- OS:
  - (+) 1-2+ bulbar conj injection 360
  - **(+) central stromal edema (5x5.5mm oval), with endo folds and MCE overlying swelling**
  - (+) central stromal scar?
  - (-) epi defect or dendrite
- AC deep and quiet OU

27

Corneal Edema

Case 2 – 41yo Caucasian male



28

Corneal Edema

Case 2 – 41yo Caucasian male

29

Corneal Edema

Case 2 – HSV Disciform Keratitis

What is it?
- Immune-mediated response of endothelium to non-replicating herpes virus particles
- Considered a "localized endotheliitis"
  - Disciform is most common
- Endothelial inflammation affects the Na+/K+ ATPase pump density regulating ion influx and water

Clinical features[1]
- Disc-shaped area of stromal edema in central or paracentral cornea
  - Often without epithelial involvement
- Sharp demarcation between involved and uninvolved stroma
- Focal KPs underlying the edema

Prevalence
- Accounts for ~2% of initial ocular HSV presentations[2]
- Responsible for 20-48% of disease recurrences[2]

30

Corneal Edema

Case 2 – HSV Disciform Keratitis

Epidemiology
- HSV-1 is endemic in human populations (~90%)
  - Ocular involvement occurs ~5%
- Prevalence of ocular disease 150 per 100,000
  - Majority of cases are unilateral with recurrences affecting the same eye
  - Recurrences reported at 10% (1-yr), 23% (2-yrs), 40% (5-yrs) and 67% (10-yrs)

Disease Process
- Active Infection
  - Corneal cells infected with HSV induce an immune response cascade
- Fibrosis
  - Recruited inflammatory cells cause tissue destruction and scarring

31

Corneal Edema

Case 2 – HSV Disciform Keratitis

How I treated it...
- Oral valacyclovir 500mg TID
- Topical prednisolone acetate 1% QID OS
- Topical timolol maleate 0.5% qAM OS

American Academy of Ophthalmology Medical Management

APPENDIX VI: Summary of Treatment Recommendations

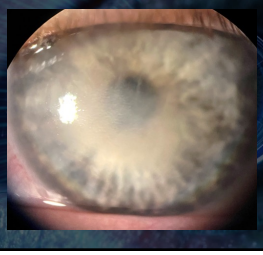
3. Endothelial Keratitis
(Therapeutic dose of topical corticosteroid PLUS therapeutic dose of oral antiviral)
Prednisolone 1%: 6–8 times daily **plus**
Acyclovir (Zovirax®): 400 mg 3–5 times daily **or**
Valacyclovir (Valtrex®): 500 mg twice daily **or**
Famciclovir (Famvir®): 250 mg twice daily
The oral antiviral agent is reduced to prophylactic dose after 7–10 days and maintained as long as topical corticosteroids are in use. As disease comes under control, the topical corticosteroid can be tapered slowly. Note: there is no clinical trial data to support a specific recommendation for length of treatment.

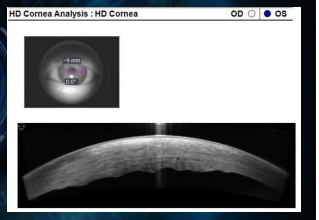
32

Corneal Edema

Case 2 – HSV Disciform Keratitis

Initial presentation….



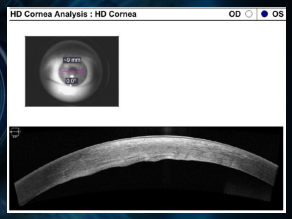


33

Corneal Edema

Case 2 – HSV Disciform Keratitis

5 days later….

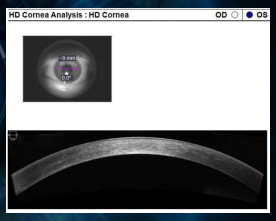


34

Corneal Edema

Case 2 – HSV Disciform Keratitis

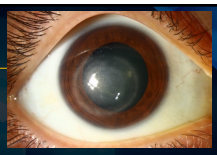
6 days after that….



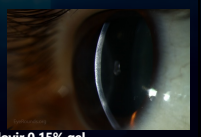
35

Corneal Edema - Take Home Points

HSV Disciform Keratitis



- Diagnosis
  - Epithelial keratitis
    - Dendritic
    - Geographic
    - Marginal
  - Stromal keratitis
    - Immune keratitis = Inflammatory (~90%)
    - Interstitial keratitis = Active infection
  - Endotheliitis (disciform keratitis)
- Medical Management
  - Oral acyclovir 400mg 5X/d or valcyclovir 500mg 3X/d
  - Topical trifluridine 1% or *acyclovir 3% ointment* or ganciclovir 0.15% gel



36

Take Home Points

HSV Disciform Keratitis - HEDS Legacy

HEDS Key Clinical Questions and Studies

QUESTION	FINDINGS	REFERENCE
Are topical steroids beneficial in treating HSV stromal keratitis?	Yes. Topical steroid significantly reduced stromal inflammation and duration of keratitis.	Wilhelmus KR et al., for the Herpetic Eye Disease Study Group. Herpetic eye disease study: A controlled trial of topical corticosteroids for herpes simplex stromal keratitis. *Ophthalmology* 1994;101(12):1883-1895; discussion 1895-1896.
Does the addition of oral acyclovir to a regimen of topical steroid and trifluridine improve the clinical outcome in stromal keratitis?	No treatment benefit was seen in nonnecrotizing stromal keratitis; too few patients with necrotizing stromal keratitis to assess benefit.	Barron BA et al., for the Herpetic Eye Disease Study Group. Herpetic eye disease study: A controlled trial of oral acyclovir for herpes simplex stromal keratitis. *Ophthalmology* 1994;101(12):1871-1882.
Is oral acyclovir helpful in treating iridocyclitis?	Too few patients to attain statistical significance, although the trend favored treatment with oral acyclovir.	A controlled trial of oral acyclovir for iridocyclitis caused by herpes simplex virus. The Herpetic Eye Disease Study Group. *Arch Ophthalmol* 1996;114(9):1065-1072.
Does oral acyclovir prevent development of stromal keratitis in patients with epithelial keratitis?	No difference was apparent between the acyclovir and placebo groups.	A controlled trial of oral acyclovir for the prevention of stromal keratitis or iritis in patients with herpes simplex virus epithelial keratitis. The Herpetic Eye Disease Study Group. *Arch Ophthalmol* 1997;115(6):703-712.
Does prophylaxis with oral acyclovir reduce recurrence of HSV?	Yes. Recurrence was reduced by 45% in the acyclovir group compared with placebo.	Wilhelmus KR et al., for the Herpetic Eye Disease Study Group. Acyclovir for the prevention of recurrent herpes simplex virus eye disease. *N Engl J Med.* 1998;339(5):300-306.
What triggers HSV recurrence?	None of the factors studied were confirmed as triggers as recorded by patients in weekly logs.	Psychological stress and other potential triggers for recurrences of herpes simplex virus eye infections. The Herpetic Eye Disease Study Group. *Arch Ophthalmol* 2000;118(9):1274-1276.

- **Epithelial HSV keratitis**
  - **Antiviral ONLY**
    - **Oral vs. Topical**
- **Stromal HSV keratitis**
  - **Antiviral + Corticosteroid**
    - ***Trifluradine 1% x 10-14d***
- **Longer steroid taper (>10wks) based on empirical corneal response**
- **More HSV episodes = > recurrence risk**
- **Short intervals = > recurrence risk**
- **Suppressive therapy may continue indefinitely…**

37

Take Home Points

HSV Disciform Keratitis

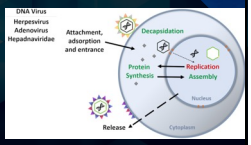
L-lysine: Antagonism with L-arginine in controlling viral infection

British Journal of Clinical Pharmacology (2022) 88 (11):4708-4723

Abstract

- Antiviral therapies are not yet able to interfere with a latent virus
  - During infection or viral reactivation, they interfere with the virus adhesion/fusion and viral protein formation
  - L-lysine contributes to the inhibition of these phases by antagonizing arginine, an essential amino acid for some herpesviruses

- ***Concurrent use of lysine and acyclovir in the treatment of keratitis may have beneficial results by competing with endogenous or exogenous arginine***
- ***Dosages range between 1500-3000mg/d***
- ***No observed adverse effect level in healthy human subjects identified at 6000 mg/d***



Proposed MOA

- *HSV cells synthesize higher levels of arginine and lower levels of lysine than human host cells*
- *Increasing cellular lysine concentrations disrupts HSV's balance between lysine and arginine and inhibits viral replication*

38

Corneal Edema

Case 3 – 34yo Hispanic male

CC/HPI	*Other pertinent history*	*Current mediations*

• CC: wax-like film over his right eye x 1 week
• HPI: (-) pain, (+) light sensitivity
	• **(+) post-LASIK keratoconus OD**
	• (-) CXL OD due to thin pachs (259um)
	• Previous Rx 1 year prior:
	  • OD: -3.25-3.50x050 20/25
	  • OS: plano-1.00x030 20/20
		• TheraTears BID OU without improvement

39

Corneal Edema

Case 3 – 34yo Hispanic male

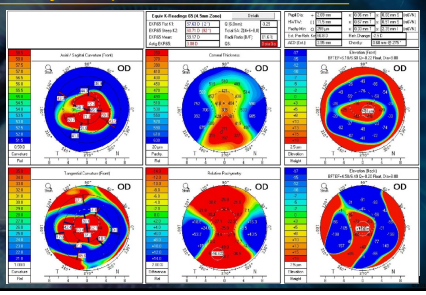
scDVA	*Entrance testing*	*IOP*

• OD: HM PH: NI
• OS: 20/20
	• Normal
	  • Pupils
	  • EOMs
	  • CVF
		• GAT
		  • OD: 8mmHg
		  • OS: 13mmHg

40

Corneal Edema

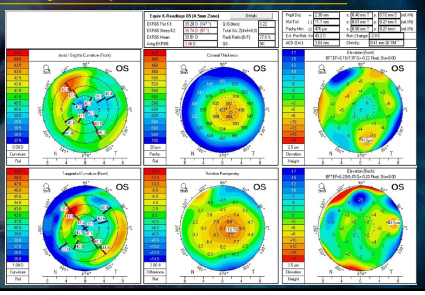
Case 3 – 34yo Hispanic male



41

Corneal Edema

Case 3 – 34yo Hispanic male



42

Corneal Edema

Case 3 - 34yo Hispanic male

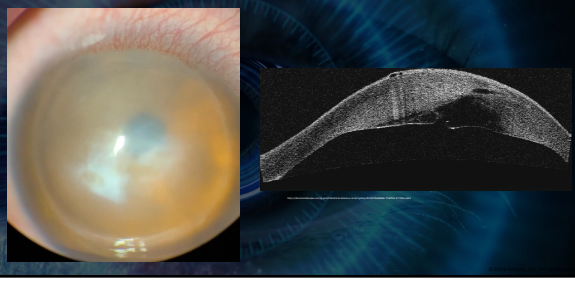
Slit lamp exam

- Normal adnexa, lids, lashes OU
- OD:
  - (+) 2+ focal bulbar injection @ 2 o'clock
  - **(+) stromal edema w/ central bullae**
- OU:
- (+) LASIK flap scar
  - (-) other scars, epi defects, infiltrates
- AC deep and quiet

43

Corneal Edema

Case 3 – 34yo Hispanic male



44

Corneal Edema

Case 3 – Corneal Hydrops

What is it?
- Sequalae of KCN or other ectasias with resulting split in Descemet layer and endothelium allow aqueous to enter the stroma and epithelium
- Associated with rapidly progressive ectasia

Clinical features?
- Slit lamp biomicroscopy:
  - Significant stromal and epithelial edema in a patient with corneal ectasia
  - Conjunctival hyperemia
- Often self-resolving over 2-4 months but can result in visually significant scarring
  - Scarring can flatten the cornea and improve CL fit if not impacting vision
- Can lead to perforation, infection, neovascularization
  - *R/O Fleischer ring!*

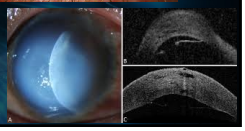
45

Corneal Edema

Case 3 – Corneal Hydrops

Patient symptoms
- Markedly reduced VA
- Epiphora
- Photophobia and pain

Prevalence?
- ~3% of patients with keratoconus
- More common in males 3:1
- Mean age of onset = 25 years
- Patients with hydrops are **6X** more likely to develop it in the other eye



46

Corneal Edema

Case 3 – Corneal Hydrops

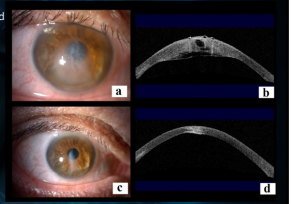
Pathophysiology related to ectasias
- Once ruptured, Descemet layer can retract and curl, making it harder for the cornea to heal[1]
  - Endothelial cells enlarge and migrate to cover the defect
- Increased risk of developing hydrops in patients with:
  - Atopic disease[1]
  - Earlier age at diagnosis
  - Steeper K values at diagnosis
  - Poor vision at diagnosis
  - Eye rubbing
- IOP possible etiologic factor of hydrops[2]

47

Corneal Edema

Case 3 – Corneal Hydrops

Current clinical management strategies
- Corneal imaging modalities such as UBM and AS-OCT
  - Allows morphometric assessments of the extent and depth of the DM tear and the corneal thickness
  - Helps predict likely clinical course and surgical planning
- Self-resolving condition that heals via DM reattachment and endothelial relayering over the bared posterior corneal stroma
  - **Can take between 3 and 36 weeks!**
- Deep anterior lamellar keratoplasty and endothelial keratoplasty in the acute phase for rapid resolution of corneal edema and immediate visual recovery
- Preventive measures include:
  - Early ectasia screening
  - Use of specialized contact lenses
  - ***Collagen cross-linking to prevent ectasia progression***



48

Corneal Edema - Take Home Points

Corneal Hydrops

Clinical profile and etiological spectrum of patients presenting with corneal hydrops over a 12-year period

International Ophthal (2024) 44 (411)

Methods

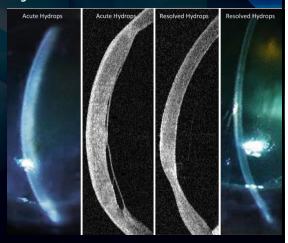
- 3,140,941 new patients presenting with clinical diagnosis of corneal hydrops in at least one eye were included in the study

Results

- 1291 eyes of 1110 patients were diagnosed with corneal hydrops
  - 84% had a unilateral presentation
  - Males (62%) and adults (63%) during the 2nd decade (43%)
  - 44% had BCVA worse than 20/400
  - 13% had BCVA between 20/70-20/200
  - ***Most common etiology:***
    - ***KCN in 1,082 (84%)***
    - Primary congenital glaucoma in 91 (7%)
  - Surgical intervention was performed in 8% with ectasia
  - Contact lenses in 29% eyes and keratoplasty in 14% eyes.

Conclusion

- Corneal hydrops is predominantly unilateral / more common in males
- KCN was the most common etiological; however
  - Risk highest in keratoglobus
- Surgical intervention was performed in a ~33% of the cases.



49

Corneal Edema

Case 4 – 25yo Hispanic male

CC/HPI	***Other pertinent history***	***Current mediations***

• CC: blurred vision in both eyes, onset 4 days prior
• HPI: (-) pain, light sensitivity, redness, discharge
	• S/p myopic LASIK OU x 6 weeks
	• Previous Rx:
	  • OD: -5.00-1.75x006
	  • OS: -3.75-1.25x159
		• PFATs prn
		• Loteprednol etabonate ointment QID OU x 4 weeks for ocular dryness
		• Confirmed d/c of post-op pred-moxi gtts

50

Corneal Edema

Case 4 – 25yo Hispanic male

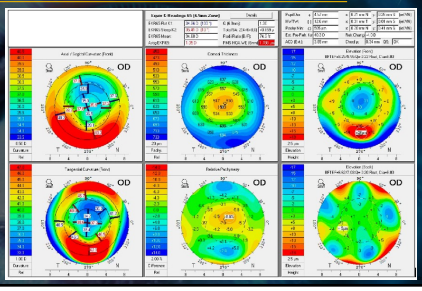
scDVA	***Entrance testing***	***IOP***

• OD: 20/60-2 PH: 20/30
• OS: 20/40 PH 20/25-1
	• Normal
	  • Pupils
	  • EOMs
	  • CVF
		• iCare:
		  • OD: 34mmHg
		  • OS: 33mmHg
		• GAT:
		  • OD: 29mmHg
		  • OS: 24mmHg
		• iCare: (outside flap)
		  • OD: 44mmHg
		  • OS: 42mmHg

51

Corneal Edema

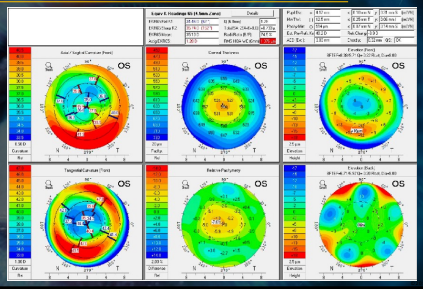
Case 4 - 25yo Hispanic male



52

Corneal Edema

Case 4 - 25yo Hispanic male



53

Corneal Edema

Case 4 - 25yo Hispanic male

Slit lamp exam

- Normal adnexa, lids, lashes OU
- (+) tr bulbar conj injection 360 OU
- (+) LASIK flap scar OU (-) other scars, epi defects, infiltrates
- **(+) diffuse corneal haze OU**
- (+) faint, black fluid cleft at flap interface with optic section
- AC deep and quiet

54

Corneal Edema

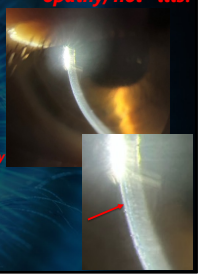
Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

-opathy, not –itis!

What is it?
- Rare LASIK complication where fluid accumulates in the interface
- Due to elevated IOP within the anterior chamber
  - Topical corticosteroid use

Clinical features
- Corneal haze
- Black fluid cleft in interface on optic section, if severe
  - Visible fluid-accumulation is ***NOT*** a requirement
- Blurred vision – often myopic shift
- ***Discrepancy between IOP measured on centrally vs peripherally***
  - Higher outside of flap

Prevalence
- 1 in 2500 LASIK cases[1]



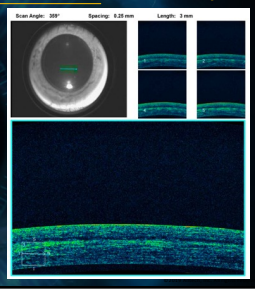
55

Corneal Edema

Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

Clinical risk factors
- History of lamellar surgery
  - (LASIK, SMILE, corneal inlays)
- Susceptible to steroid response
  - POAG, DM Type 1, connective tissue disease, high myopia

Diagnostic strategies
- Measure IOP with rebound tonometry
  - Better precision outside of LASIK flap
  - GAT incorrectly measures pressure gradient of fluid interface
- AS-OCT
  - Black fluid cleft on 5-line Raster
- Corneal tomography
  - Changes in corneal thickness
    - Helpful in monitoring resolution



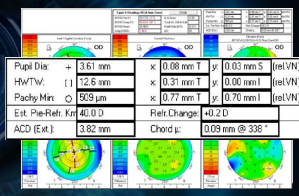
56

Corneal Edema

Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

Corneal Tomography

- Compare pre-LASIK pachymetry to post-LASIK pachymetry



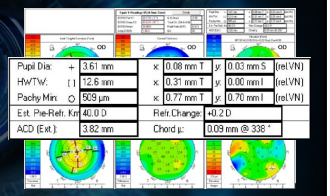
57

Corneal Edema

Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

Corneal Tomography

- Compare pre-LASIK pachymetry to post-LASIK pachymetry
- Pre-LASIK pachymetry OD: 509µm
- MRx OD: -5.00-1.75x006
  - ~16µm x 5.875D SEQ = 94µm



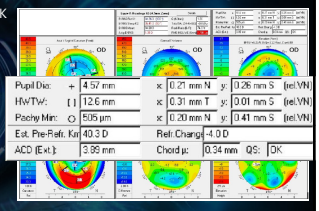
58

Corneal Edema

Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

Corneal Tomography

- Compare pre-LASIK pachymetry to post-LASIK pachymetry
- Pre-LASIK pachymetry OD: 509µm
- MRx OD: -5.00-1.75x006
  - ~16µm x 5.875D SEQ = 94µm
  - Expect a residual pach min of ~415µm
- Post-LASIK pachymetry OD: **505µm?!**



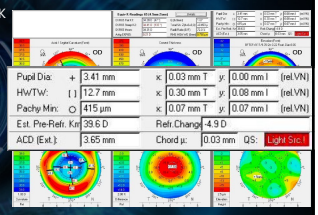
59

Corneal Edema

Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

Corneal Tomography

- Compare pre-LASIK pachymetry to post-LASIK pachymetry
- Pre-LASIK pachymetry OD: 509µm
- MRx OD: -5.00-1.75x006
  - ~16µm x 5.875D SEQ = 94µm
  - Expect a residual pach min of ~415µm
- Post-LASIK pachymetry OD: **505µm?!**
- **2 months later with treatment : 415µm** 😀

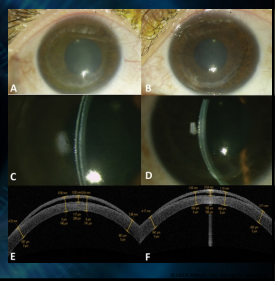


60

Corneal Edema
Case 4 – Pressure-Induced Interlamellar Stromal Keratopathy

Emerging clinical management strategies
- ***Non-responsive to anti-inflammatory drugs and topical antibiotics have no value***
- ***PISK typically worsens with topical steroid therapy***

- **Topical**
  - ***Discontinue all topical/oral corticosteroids***
  - ***Add hypotensive drops***
  - ***Can start oral CAI***
- **Surgical**
  - No great surgical option for PISK
  - DMEK can help in cases of IFS due to endothelial dysfunction

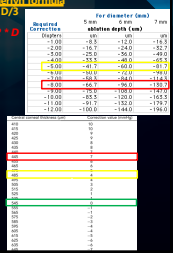


61

Corneal Edema - Take Home Points
Pressure-Induced Interlamellar Stromal Keratopathy

- Commonly misdiagnosed as DLK
  - Improper treatment may exacerbate steroid-induced IOP elevation
  - ***Severe glaucomatous damage can occur in PISK where apparent interface fluid is absent and when excessively high IOP is not accurately measured***
- ***Severe visual loss can manifest over a few months if:***
  - Proper diagnosis is not established
  - IOP reduction is not initiated
  - Steroid use is not discontinued
  - HSV-association suggested in literature
    - R/O keratic / stromal precipitates + corneal hypothesia + MHx
      - Consider oral antiviral therapy
        - acyclovir 400mg 5X/d or valcyclovir 500mg 3X/d)

Munnerlyn formula
t = S*D/3
or
t = 12 * D



62

Corneal Edema - Take Home Points
Pressure-Induced Interlamellar Stromal Keratopathy

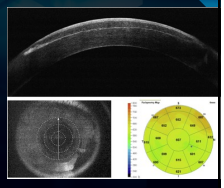
Late-onset interface fluid syndrome: Case report and literature review
Seminars in Ophthal (2022) 37(7-8)

Introduction
- IFS is an uncommon complication of LASIK
  - Generally appearing in the early postoperative period, IFS has been reported even years post-surgically

Methods
- Case report of IFS manifesting 19 years after uneventful LASIK leading to literature search for similar, late-onset cases in MEDLINE PubMed.

Results
- Interface fluid was attributed to IOP arising from POAG. Antiglaucoma drops resulted in complete fluid regression.
- Narrative review was conducted based on 29 case reports that were recovered from the literature search

Conclusion
- IFS represents an uncommon complication that may appear years post-LASIK
- Careful clinical examination and AS-OCT promote early diagnosis
- ***Cases may manifest due to elevated IOP of variable etiology or result of endothelial dysfunction***
  - ***IOP control or keratoplasty may resolve the condition***



63

Corneal Edema Management
What's Now?

- ***BCVA***
  - ***CS***
- ***MHx + OcHx + Medication Review***
  - ***CAIs / Prostaglandin analogues / Preservative hypersensitivity***
- ***SLE***
  - ***Endothelial guttata***
    - ***Hassall-Henle bodies (~60% of patients >40yo)***
  - ***Descemet's folds (striae?)***
  - ***Sub-epithelial microcystic changes***
- ***CCT***
  - ***CH vs. CRF***
  - ***Tomography***
  - ***AS-OCT***

64

Corneal Edema Management
What's Now?

- **Topical Hypertonics**
  - Muro-128 (Ointment vs. Solution)
    - More effective in epithelial, microcystic edema
- **Topical corticosteroids**
  - Dexamethasone 0.1% (Maxidex)
    - Positive effects on Na^+ /K^+ - dependent ATPase activity
  - **NEXT SLIDE…**
- **BCL vs. amniotic membrane**
  - Palliative care in bullae management
- **Topical anti-glaucoma medications**
  - AVOID PGAs and CAI
  - However….. Rho-kinase inhibitors

65

Corneal Edema Management
Topical corticosteroids

Corneal Penetration Paradigm

- **Acetate** > Alcohol > Phosphates

Consideration:
- *Treating DED or corneal edema?*
- *Reduced corneal penetration reduces risk of*
  - *IOP increase (short-term)*
  - *Lenticular changes (long-term)*

ANTI-INFLAMMATORY POTENCY OF TOPICAL OPHTHALMIC STEROIDS

CHEMICAL ENTITY	Common Brand Names	In Vivo Relative Anti-Inflammatory Activity	In Vivo Percent Aqueous Protein Reduction	In Vitro Relative GCR Internaliza-tion	In Vitro Relative Potency
Difluprednate Emulsion	Durezol	60	NA	NA	1,800
Fluorometholone Acetate	Flarex	40	NA	NA	350
Fluorometholone Alcohol	FML Forte	40	80	53	350
Dexamethasone Sodium Phosphate	Maxidex, Decadron	25	90	27	400
Loteprednol Etabonate	Lotemax, Alrex	25	100	100	550
Rimexolone	Vexol	25	NA	NA	300
Medrysone	HMS	4	NA	NA	200
Prednisolone Acetate	Pred Forte	4	110	58	600
Prednisolone Acetate	Generic	4	5	33	600
Prednisolone Sodium Phosphate	Inflamase Forte	4	NA	NA	600

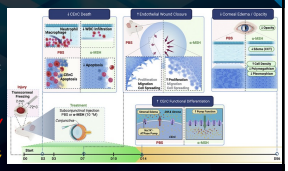
66

Corneal Edema
What's Next?

Neuropeptide α-Melanocyte-Stimulating Hormone Prevents Persistent Corneal Edema following Injury

Am J Path (2024) 194 (1):150-164

- Corneal endothelial cells (CEnCs) regulate corneal hydration and maintain tissue transparency through their barrier and pump function
- Currently, corneal transplantation is the only established therapy for restoring endothelial function and there are no pharmacologic interventions available for restoring endothelial function
- Study investigated efficacy of neuropeptide α-melanocyte–stimulating hormone *(α-MSH) in promoting endothelial regeneration during the critical window between ocular injury and the onset of endothelial decompensation*
- *α-MSH following injury prevented corneal edema and opacity, reduced leukocyte infiltration and limited CEnC apoptosis while promoting their proliferation*
- *Results suggest that α-MSH has a proregenerative and cytoprotective function on CEnCs and shows therapeutic promise in prevention and management of corneal endothelial dysfunction*



67

Corneal Edema
Takeaways

- **Prompt, accurate diagnosis of cornea edema is necessary to avoid severe vision loss in your patients**
- **Various technologies outside of the slit lamp are useful in diagnosis and monitoring of corneal edema**
- **Treatment and current therapies are evolving**

68

69