Corneal Degenerations
An investment in knowledge pays the best interest

- Benjamin Franklin, American founding father, scientist, publisher and wit...

Outline

- Briefly review differences between degenerations & dystrophies
- Survey the principal corneal degenerations
Corneal Degenerations & Dystrophies

**Degenerations**
- Changes in tissues that cause deterioration and sometimes impair function
- May represent normal aging, or disease
- If bilateral, often asymmetric
- Affects peripheral cornea ± vessels
- No genetic predisposition
- Usually present middle to older age

**Dystrophies**
- Hereditary
- Symmetric
- Bilateral
- Usually affects central cornea
- Avascular
- Unrelated to systemic or local disease
Corneal Degenerations & Dystrophies

- Degeneration frequency:
  - Common: Age related (involutional)
  - Less common: related to local & systemic conditions (noninvolutional)

Corneal Degenerations

- Involutional (aging):
  - Morphologic changes
  - Pinguecula
  - Limbal girdle of Vogt
  - Arcus
  - Cornea farinata
  - Descemet’s striae
  - Hassal-Henle bodies
  - Crocodile (mosaic) shagreen
  - Furrow degeneration
Corneal Degenerations: Involutional

Noninvolutional:
- Pterygium
- Amyloid degeneration
- Band keratopathy
- Spheroidal
- Salzmann’s nodular
- Terrien’s marginal
- Coats’ white ring
- Pellucid marginal
- Lipoidal
- Limbal stem cell deficiency

Adverse/toxic conditions
Non-Involutional Corneal Degenerations

- Pterygium:
  - Fibrovascular overgrowths from bulbar conjunctiva
  - Interpalpebral fissure
  - May be nasal and temporal (double pterygium)

Non-Involutional Corneal Degenerations

- Pterygium:
  - Grayish flat avascular edge common
  - Iron line (Stocker’s)
  - Chronic injection associated with growth
  - May contract/strabismus
Non-Involutional Corneal Degenerations

- Pterygium epidemiology:
  - UV
  - Heat, wind, dust, dry atmosphere
  - Prevalence directly related to proximity to equator (e.g. Central America, Caribbean, Southern USA)
  - Men, outdoor workers
  - Non spectacle wearers, no hat
  - Frequently related to childhood/youth exposure

- Initial event may be limbal stem cell damage/ basement membrane or Bowman’s layer damage
- Histologically identical to pinguecula:
  - elastotic degeneration of the subepithelial connective tissue
  - increased vascularity
  - possible mild epithelial dysplasia (precancer)
  - Increased mast cells
Non-Involutional Corneal Degenerations

- Pterygium symptoms:
  - Usually asymptomatic
  - May be photophobic
  - Tearing
  - Foreign body sensation
  - Induced with-the-rule astigmatism
  - Irregular astigmatism

- Block vision with visual axis overgrowth
- Diplopia in peripheral gaze from limited rotation (especially in recurrences)
Non-Involutional Corneal Degenerations

- **Pterygium Treatment:**
  - Surgery indicated when with the rule irregular astigmatism induced by keratometry or photokeratoscopy

  - Pterygium excision alone has 40-50% recurrence rate
  - 50% of recurrences within 3 months, most by 1 year
  - Mitomycin C chemotherapy ~10%
  - Conjunctival or amniotic graft ~10%

  Call us Today See Better Tomorrow

Pterygium surgery
Superficial lamellar keratectomy/conjunctival surgery for Pterygium

Gold Standard Recurrence Rate:
- MMC+conjunctival Graft: ~5%

Pterygium surgery
- SLK of corneal lesion
- Excision of bulbar conjunctival tissue
- Application of 0.03% MMC for 2 minutes
- Conjunctival pedicle graft from upper bulbar conjunctiva (or amniotic membrane)
Conjunctival Graft

- Free or pedicle graft

Non-Involutional Corneal Degenerations

- Pterygium Surgery caveats:
  - Incidence of recurrence <10% with conjunctival grafting, intraoperative or postoperative Mitomycin C
  - Beta-irradiation may induce severe scleromalacia
  - Topical mitomycin C or Thiotepa may cause skin depigmentation
  - Mitomycin C can be endothelial toxic
Conjunctival or Amniotic membrane graft after Pterygium Excision

- Helps prevent scleral melts after Mitomycin C treatment

Amniotic Membrane Grafting (AMT)

Mother’s own remedy for Ocular Surface Disease

Toya Graham: Baltimore “mom of the year 2015”
Amniotic Membrane Grafting (AMT)

*Mother’s own remedy for Ocular Surface Disease*
(Kenyon, KR; Cornea. 24(6); 2005: 639-642)

Cornea-like basement membrane-coated extracellular matrix/collagen containing:

- growth factors
  - Neurotrophins
  - Cytokines
- Anti-inflammatory
- Anti-fibroblastic
- Anti-angiogenic
- Anti-microbial activity
- Nearly no immunogenicity
Ocular Surface Reconstruction

- Amniotic membrane graft
  - Readily available
  - Lasts 1-2 weeks/ dissolves
  - Scleral epithelial defects
  - Helps heal persistent corneal epithelial defects

- May be sutured, glued or applied as a “contact lens”

Amniotic Membrane Graft

- 2 Types for Clinic Use!
  - Dehydrated extracellular matrix
    - Use with bandage contact lens
  - Frozen on PMMA carrier ring

- Use for corneal
  - Indolent epithelial defects
  - Ulcers
  - Band keratopathy irritations
  - Bullous keratopathy
  - Chemical/ thermal burns
Amniotic Membrane Graft

- From full term placenta
  - Freeze dried
  - Frozen

Frozen AmnioGraft

Easy to determine AMNIOGRAFT® orientation: Stromal side is "sticky;" Epithelial side is not.

"Sticky," Stromal side
(manufactured adhered to the nitrocellulose paper)

"Non-Sticky" Epithelial side
Product Sizes
- 12mm disc
- 15mm disc
- 1.5 x 2.0 cm²
- 2.5 x 3.0 cm²

Circular disc used with bandage contact lens for retention

Lid speculum
Apply to dry cornea
Apply bandage contact lens
Amniotic Membrane Graft

Polycarbonate ring set sits behind lid margins for patient comfort.

Patient can be examined while ProKera® is inserted.

Back to Pterygium Surgery
Non-Involutional Corneal Degenerations

- **Pterygium Surgery: Postop care**
  - Fox shield bedtime for 1 month to protect conjunctival graft
  - UV protection

- **After cornea has epithelialized, examine patient monthly:**
  1. **1st Month:** qid Tobramycin + Loteprednol (Lotemax)—[sutures, bare sclera]
  2. **2nd Month:** tid Loteprednol
  3. **3rd Month:** bid Loteprednol
  4. **4th Month:** q day Loteprednol
   ...Continue if necessary until injection resolved

Non-Involutional Corneal Degenerations

- **Pseudopterygium:**
  - Stimulated by peripheral corneal disease
    - Ulcers
    - Herpes
    - Rosacea keratitis
    - Phlyctenular diseases
  - In classic cases, may pass probe between pseudopterygium and globe
  - True pterygia are tightly adherent
Non-Involutional Corneal Degenerations

- Pseudopterygium:

Non-Involutional Corneal Degenerations

Amyloid

- Primary localized amyloid
- Secondary localized amyloid
- Primary systemic amyloidosis
Non-Involutional Corneal Degenerations

- Primary localized amyloid
  - Lattice *dystrophy*
  - Gelatinous drop-like *dystrophy*
  - Polymorphic amyloid degeneration

- Polymorphic amyloid degeneration
  - 6th decade
  - Lesions do not reduce vision, cornea lustrous
  - Central, peripheral or annular
  - Mid to deep stroma
  - Gray on direct, translucent indirect illum
  - Polymorphic fleck, filiform or linear
  - May look like lattice dystrophy or guttata
Non-Involutorial Corneal Degenerations

- Secondary localized amyloid
  - In cornea or conjunctiva:
    - After trauma
    - After chronic ocular diseases, e.g.
      - Trachoma
      - Sarcoid
      - Phlyctenular disease
      - Uveitis, glaucoma, IK
      - Leprosy
      - Keratoconus
      - Climactic droplet keratopathy

- Secondary localized amyloid?
  - 58 yo caucasian female with occasional redness
    - DDX included MALT (mucosal associated lymphoid tissue)
    - Systemic work up for primary systemic
Non-Involutional Corneal Degenerations

- Primary systemic amyloidosis
  - Appear as corneal/ conj. mass(es)
  - Salmon pink to yellow white
  - Fleshy, waxy, +/- nodular
  - Subepithelial pannus

Non-Involutional Corneal Degenerations

- Primary systemic amyloidosis
  - May have lattice like dystrophy
    - Less central, but extend to periphery unlike lattice dystrophy
  - Skin changes:
    - Lid purpura, papillary changes
    - Conjunctival changes
  - Ophthalmoplegia, ptosis
  - Vitreous veil-like opacities
  - Glaucoma
Non-Involutional Corneal Degenerations

Band keratopathy

- Usually not hereditary
  - Calcific form
    - Grayish white, interpalpebral
    - Begin at limbus, lucent interval (Bowman’s)
    - “Swiss cheese” holes
      - Corneal nerves penetrate Bowman’s layer

Non-Involutional Corneal Degenerations

Band keratopathy

- Uric acid form
  - hyperuricemia
  - Brownish white
  - Severe spheroidal form
Non-Involutional Corneal Degenerations

- **Calcific Band keratopathy**
  - Increased Ca or phosphate levels
  - Elevation of pH (alkaline)
  - Concentration by evaporation
  - Uveitis alters corneal metabolism causing rise of pH

- **Band keratopathy**
  - Usually not hereditary
  - Calcific origin (vs. uric acid)
    - Drugs (pilocarpine, phosphate steroids, preservatives)
    - Chronic dry eye
    - Localized inflammatory disease
      - Old interstitial keratitis, corneal edema, trauma
    - Chronic ocular inflammation (uveitis)
      - JRA & uveitis, phthisis
    - Glaucoma
    - Systemic disease: hypercalcemia

Systemic disease: hypercalcemia
Chelation of Band Keratopathy

Chelation of band keratopathy (calcific)
- Calcium salt deposits in basement membrane, Bowman’s and anterior stroma

Chelation of Band Keratopathy

Chelation of band keratopathy (calcific)
- Removal by Scraping and 0.01M Disodium EDTA
Chelation of Band Keratopathy

- Surgical Procedure

Non-Involutional Corneal Degenerations

Spheroidal degeneration
(Climactic droplet keratopathy)
- Interpalpebral, suggesting actinic etiology
- Tropical, arid climates
- Wind, sand, ice
- Outdoor occupations; increasing age
- Primary corneal, secondary corneal and conjunctival types
- A form of elastotic degeneration
Non-Involutional Corneal Degenerations

- Spheroidal degeneration (Climactic droplet keratopathy)
  - Clinical
    - Intercalpebral
    - Spherical, golden brown, translucent
    - Drop-like
    - Fluoresce brightly with UV light
    - Begin 3, 9:00, advance centrally
    - Progressively darken/ opacify
    - May become plaque-like

Non-Involutional Corneal Degenerations

- Spheroidal degeneration
  - Secondary corneal types associated w/ long-standing eye disease
    - Pinguecula or pterygium
    - Glaucoma
    - Herpes
    - Dystrophies (Fuchs, Lattice)
    - Failed corneal grafts
    - Climactic insult
Non-Involutional Corneal Degenerations

- Treatment of Spheroidal degeneration
  - Usually asymptomatic
  - In Mongolia, 7-15% of corneal blindness
  - SLK or lamellar keratoplasty if necessary

Non-Involutional Corneal Degenerations

Salzmann's nodular degeneration

- Non-inflammatory
- Adults of any age
- Most often bilateral
- May have history of previous inflammation, especially phlyctenular
- Possibly related to limbal stem cell damage
Non-Involutional Corneal Degenerations

- **Salzmann's nodular degeneration**
  - May be at axial edge of pannus
  - Superior bilateral form typically progresses
  - Recurrent micro erosions promote growth
  - Surgical excision indicated if visual axis threatened/ induced astigmatism

Non-Involutional Corneal Degenerations

- **Salzmann's nodular degeneration**
  - Surgical excision indicated if visual axis threatened/ induced astigmatism
Non-Involutional Corneal Degenerations

Surgical treatment of Salzmann’s nodular degeneration
- First treat any MGD/ inflammation
- Then SLK is performed
  - PTK may induce refractive changes
  - Histologically shows hyaline plaques between epithelium & Bowman’s and may replace Bowman’s
  - Basement membrane degeneration
  - Bilateral form may recur

Superficial Lamellar Keratectomy

Indications:
- Epithelial basement membrane degeneration (maps/ fingerprints)
- Salzmann’s nodular degeneration
- Corneal biopsy
Superficial Lamellar Keratectomy

EBMD & Salzmann’s nodular degeneration

Remove lesion when significantly affecting refractive error/visual axis
Superficial Lamellar Keratectomy

Remove when significantly changing refractive error or threatens visual axis
Superficial Lamellar Keratectomy

Salzmann’s nodular degeneration

- Slit lamp
- Lid speculum
- Topical proparacaine
- #57 blade

Postop:
- Antibiotic steroid combination until epithelialized
- 3-4 months to taper topical steroids
Non-Involutional Corneal Degenerations

Terrien’s marginal degeneration
- Uncommon marginal thinning
- Males more than females
- Bilateral
- Any age
- Gradual to rapid progression
- Usually asymptomatic until astigmatism

Non-Involutional Corneal Degenerations

Terrien’s marginal degeneration
- Marginal stromal thinning, opacification
- Superficial vascularization
- Axial “lipid” line
- Begin superonasally,
  punctate opacities with lucid interval
- Remains epithelialized, no steep edge
- Progresses circumferentially
- Rare cases centrally
- Inflammatory type w/ episcleritis/scleritis
Non-Involutional Corneal Degenerations

- Terrien’s marginal degeneration
  - Cause unknown
  - Phagocytosis of collagen by histiocytes
  - Lysosomal activity
  - DDX: Mooren’s ulcer—much more inflammation

Non-Involutional Corneal Degenerations

- Treatment of Terrien’s marginal degeneration
  - Low dose steroids
  - RGP contact lenses for astigmatism
  - if rupture/ perforation possible, lamellar tectonic keratoplasty (crescentic)
Non-Involutional Corneal Degenerations

- Treatment of Terrien’s marginal degeneration
  - Crescentic keratoplasty

Crescentic Tectonic ALKP: Indications

- Severe Terrien’s marginal degeneration
  - N.T.: 40 y.o. wf; contact lens failure
Crescentic Tectonic ALKP: Indications

- N.T.: Severe Terrien’s marginal degeneration: tectonic keratoplasty required

Tectonic ALKP

- B.G.: 50 y.o. wf, Crescentic Keratoplasty for severe Terrien’s
**Tectonic ALKP**

- **B.G.: Crescentic Keratoplasty**

**Non-Involutional Corneal Degenerations**

- Coat’s white ring
  - Metallic foreign body
  - Granular, white anterior stromal
  - Associated with residual iron deposition in Bowman’s/ anterior stroma
Non-Involutional Corneal Degenerations

- Pellucid marginal degeneration
  - Uncommon form of ectasia
  - Inferior cornea thins 4-8:00
  - Avascular, clear stroma

Non-Involutional Corneal Degenerations

- Pellucid marginal degeneration
  - Central corneal thickness wnl
  - Against-the rule cylinder
  - No Fleischer ring, Vogt’s striae or cone
Non-Involutional Corneal Degenerations

- Pellucid marginal degeneration
  - Onset age 20-40
  - No sex predilection
  - Not familial (but may be higher astigmatism in family)
  - Scarring/ hydrops can develop (Descemet rupture)

Non-Involutional Corneal Degenerations

- Treatment of Pellucid marginal degeneration
  - RGP contact lens/ scleral lens
  - Corneal UVA/riboflavin cross-linking
  - Eccentric lamellar crescentic keratoplasty
Tectonic lamellar keratoplasty

- Crescentic Keratoplasty
  --Pellucid marginal degeneration
- Subsequent Penetrating Keratoplasty or DALK

Crescentic Keratoplasty

- H. H.: 50 yo w male, Pellucid, contact lens failure
- Crescentic keratoplasty resulting in BCVA 20/400
- Subsequent penetrating keratoplasty
Crescentic + Penetrating Keratoplasty

- H. H.: Crescentic keratoplasty, subsequent penetrating keratoplasty

BCVA 20/40
Non-Involutional Corneal Degenerations

- Lipid degeneration
  - Primary form (rare)
  - Secondary forms
  - Histologically
    - Cholesterol
    - Neutral fats
    - Phospholipids

- No previous history of disease
- No vascularization
- Serum lipids usually normal
Non-Involutional Corneal Degenerations

- **Lipid degeneration**
  - Another form of bilateral primary disease
    - No previous eye disease
    - No vascularization
    - Serum lipids normal

Non-Involutional Corneal Degenerations

- **Lipid degeneration (cont)**
  - Primary forms (rare)
    - Tangier disease (low HDL); LCAT deficiency: (corneal cholesterol)

Opacity varies with form of LCAT deficiency & HDL effects
Non-Involutional Corneal Degenerations

◆ Lipid degeneration
  – **Secondary** form: lipoidal degeneration
  – May involve increased vascular permeability, excess lipid production or inability to metabolize lipids
    ◆ Trauma
    ◆ Ulceration
    ◆ Hydrops
    ◆ Interstitial keratitis
    ◆ H. zoster keratitis

Non-Involutional Corneal Degenerations

◆ Lipid degeneration (cont)
  – Primary & secondary forms may require penetrating or lamellar keratoplasty
Non-Involutional Corneal Degenerations

- **Dellen**
  - Localized dryness and stromal thinning
  - Tear film instability
  - Usually peripheral adjacent to acute elevations of conjunctiva, e.g. grafts, or chemosis
  - Respond well to lubrication or patching
Non-Involutional Corneal Degenerations

- Dellen Treatment
  - Lubrication
  - Patching (24 hour)
  - Bandage large dia. contact lens
  - If indolent corneal erosion develops
    - Amniotic membrane application

Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)

Secker, Daniels
Non involutional Corneal Degenerations

✿ Limbal Stem Cell Deficiency (LSCD)
  ➢ Genetic
  ➢ Traumatic/iatrogenic
  ➢ Ocular surface tumors, pterygia
  ➢ Acquired

✿ Limbal Stem Cell Deficiency (LSCD)
  ❑ Genetic
  ❑ Pax6 gene mutations: aniridia, Peter’s anomaly
  ❑ EECD (ectrodactyly-ectodermal dysplasia-clefting dystrophy)
  ❑ KID syndrome (keratitis-ichthyosis-deafness)
  ❑ Xeroderma pigmentosa
  ❑ Dominantly inherited keratitis
  ❑ Turner Syndrome
  ❑ Dyskeratosis congenita
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Genetic:
    - aniridia

Non involutional Corneal Degenerations

- Limbal Stem Cell Degeneration (LSCD)
  - Traumatic/ iatrogenic
    - Chemical
    - Thermal
    - Multiple ocular surgeries/ cryo
    - Radiation, chemotherapy
    - BAK/ glaucoma meds
    - Contact lens overwear/ improper fit and follow up
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Traumatic
  - Chemical: Alkali burn; acid burn

Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Traumatic/iatrogenic (That’s us, folks!)
  - Ocular surgeries

ICCE  LRI
Non involutional Corneal Degenerations

- Limbal Stem Cell Degeneration (LSCD)
  - Traumatic/iatrogenic
    - Preservative BAK/glaucoma meds in dry eye

- Limbal Stem Cell Deficiency (LSCD)
  - Traumatic/iatrogenic
    - Contact lens associated: e.g. tight lens, dry eye & overwear syndromes
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Ocular surface tumors, pterygium

Non Involuntary Corneal Degenerations

- Limbal Stem Cell Degeneration (LSCD)
  - Ocular surface tumors, pterygium
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Acquired
    - Inflammation
    - Stevens-Johnson (erythema multiforme)
    - OCP (pemphigoid)
    - GVHD (graft vs host)
    - Chronic allergy
    - Neurotrophic keratitis
    - Chronic bullous keratopathy

Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Acquired
    - Inflammation e.g. rosacea keratitis
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Acquired:
    - SJS (Stevens Johnson Syndrome); TEN (toxic epidermal necrolysis)

Non involutional Corneal Degenerations

Spectrum of Disease

- Erythema multiforme: no mucus membrane / eye involvement

**EYE**

- SJS Stevens Johnson Syndrome
  - \( \leq 10\% \) epidermal detachment
- TEN Toxic epidermal necrolysis
  - \( >30\% \) epidermal detachment
  - \( >50\% \) drug induced
Non involutional Corneal Degenerations

- Limbal Stem Cell Deficiency (LSCD)
  - Traumatic/iatrogenic
  - Ocular surface tumors, pterygium
  - Acquired
    - Inflammation
    - Stevens-Johnson (erythema multiforme)
    - OCP (pemphigoid)
    - GVHD (graft vs host)
    - Chronic allergy
    - Neurotrophic keratitis
    - Chronic bullous keratopathy

Ocular Surface Rehabilitation and Reconstruction for LSCD

- Limbal stem cell deficiency
  - Stop inciting irritants
    - Preservatives, glaucoma drops
Ocular Surface Rehabilitation and Reconstruction for LSCD

- Limbal stem cell deficiency
  - Treat dry eyes/ MGD!
    - PF tears, punctal plugs, cyclosporine, PF steroid (loteprednol ointment, compounded dexamethasone)
    - ASED’s (autologous serum eye drops)

- AMT (amniotic membrane)
  - Prokera (growth factors, anti-inflammatories)
Ocular Surface Rehabilitation and Reconstruction for LSCD

- Limbal stem cell deficiency
  - Limbal stem cell grafting (KLAL)
  - CLET (Ex vivo cultured limbal epithelial transplant (not available in USA)

Corneal Degenerations

An Ounce of Prevention is Worth a Pound of Cure
- Benjamin Franklin -