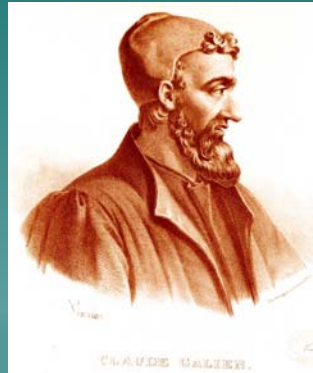


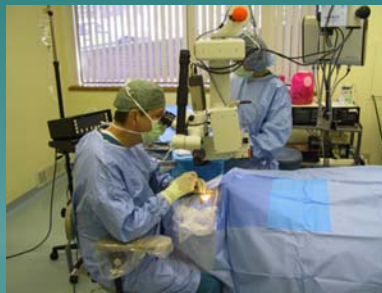
## Proverbs

- ◆ The physician is only nature's assistant—*Galen*



## Proverb

- ◆ Surgery is an admission that we have failed medical treatment--  
*Anonymous*



## Proverb

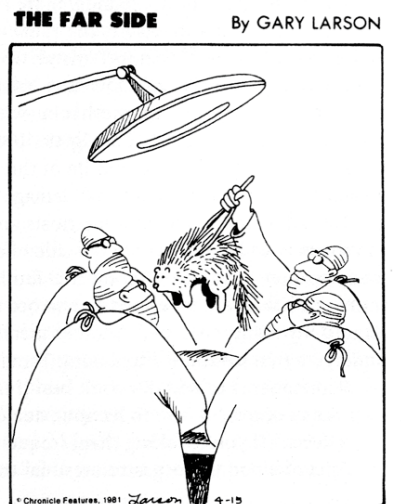
- ◆ Surgery does the ideal thing, it separates the patient from the disease—*Logan Clendening, MD*



## Surgery & Surgeons



"Whoa! That was a good one! Try it, Hobbs — just poke his brain right where my finger is."



"Well, I guess that explains the abdominal pains."

## Surgical Decisions



*Between two evils, I always like to  
take the one I've never tried before*

—Mae West, American actress

1893-1980

## Lecture Outline

- ◆ Tissue glue Advance
- ◆ Management of OSSN
- ◆ Corneal Transplantation: Selected techniques and advances
- ◆ Surgical Options for Keratoconus



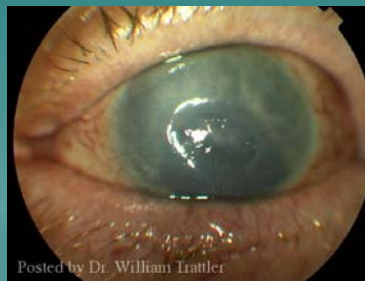
- ◆ I learned a long time ago that minor surgery is when they do the operation on someone else, not you

—Bill Walton, NBA legend

## Tissue glue

### Indications

- ◆ Perforated bacterial ulcers
- ◆ Neurotrophic ulcers seen with HZV, HSV, s/p surgery for acoustic neuroma
- ◆ Corneal surgery wound leaks



Posted by Dr. William Trattler

## Tissue glue: Neurotrophic ulcer

- ◆ Sterile cyanoacrylate glue
- ◆ (e.g. dental glue (Periacryl, Histoacryl [Canada])



## Tissue glue: Neurotrophic ulcer

- ◆ Resistant to patching, punctal plugs, bandage contact lenses, AMT



## Perforations: cyanoacrylate glue

- ◆ Emergency closure
- ◆ Usually only temporizing measure while surgery is being scheduled



## New ReSure Corneal Sealant

- ◆ Is there a place for clinic use?
  - Currently approved for cataract surgery



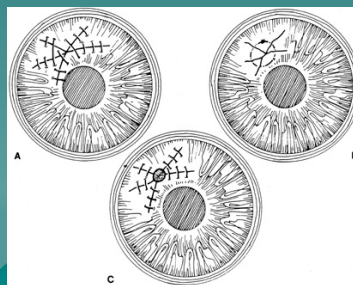
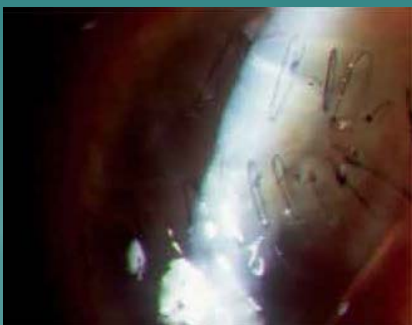
## Resure Corneal Sealant

- ◆ ReSure tissue glue
  - Polyethylene glycol (PEG) hydrogel technology



## Corneal Laceration Repair

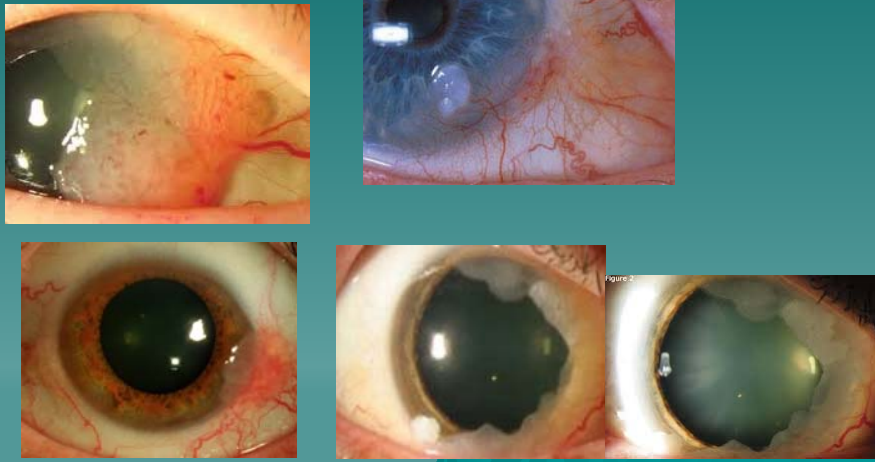
- ◆ ReSure tissue glue
  - Potential adjunct for complex laceration repair





## OSSN: Ocular surface squamous neoplasia (CIN)

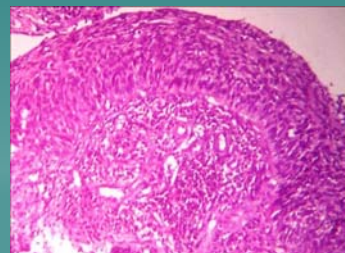
- ◆ Often overlooked with pterygium dx



## OSSN: Ocular surface squamous neoplasia



- ◆ Treatment Options paradigm shift
  - Traditional:
    - Excisional biopsy with adjuvant MMC, cryopexy and AMT
    - ◆ Advantage is histologic confirmation



## OSSN: Ocular surface squamous neoplasia

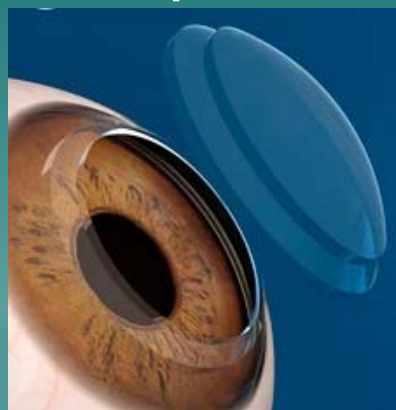


- ◆ Recent trend:
  - Topical MMC 0.4 mg/ml
  - Topical Interferon (IFN a2b-1M units/ml)
  - Topicals have equal or fewer recurrences and later time of recurrence than surgical treatment
  - Most recurrences within 2 years

Besley et al AJO 2014 jFeb; 157(2):207-93



## Corneal Grafting: Selected Technique Update



## CORNEAL GRAFTING UPDATE

### Outline

- ◆ Corneal transplantation
  - ANTERIOR LAMELLAR (ALKP)
    - ◆ Tectonic/ patch grafts (LKP)
    - ◆ Deep Anterior Lamellar (DALK)
  - ENDOTHELIAL KERATOPLASTY (EK)
    - ◆ DLEK—*now rarely used*
    - ◆ DSEK; **DSAEK**
    - ◆ **DMEK**; DMAEK
  - PENETRATING KERATOPLASTY (PK)
    - ◆ Manual trephine PK (PKP)—*most common*
    - ◆ **Femtosecond (FPK)**
  - KERATOPROSTHESIS
    - ◆ Temporary
    - ◆ Permanent (KPro)

## Lamellar Keratoplasty

- ◆ Takes advantage of lamellar architecture



(From Fine ES: *Ocular histology: a text and atlas*, ed. 2, Hagerstown, 1979, Harper & Row.)

## ANTERIOR LAMELLAR/ TECTONIC

### ◆ TYPES

- Free hand
- Trefine
- Crescentic
- Automated microkeratome
- Femtosecond laser



## ANTERIOR LAMELLAR/ TECTONIC GRAFTING

### ◆ INDICATIONS

- Descemetocoele/perforations
- Corneoscleral limbal melts
- Anterior stromal scars (e.g. herpetic)
- Anterior stromal dystrophies (granular, lattice)
- Chemical burn scars (after limbal grafting)
- Ectasias (keratoconus, pellucid, keratoglobus, post LASIK)
  - ◆ Progression to transplant may become a historical curiosity!

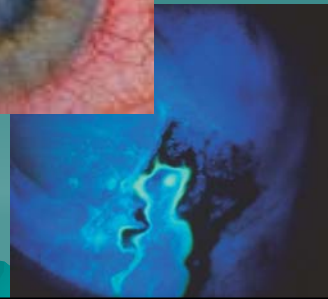


## TECTONIC ANTERIOR LAMELLAR KERATOPLASTY (ALKP)

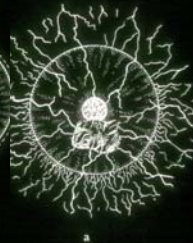
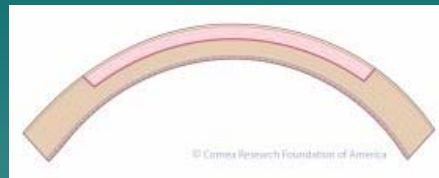
### ◆ Indications

– Severely thinned corneas,  
descemetocelles & perforations

- ◆ Bacterial
- ◆ Viral
- ◆ Fungal
- ◆ Amebic
- ◆ Neurotrophic
- ◆ Mooren's ulcer
- ◆ Rheumatologic conditions



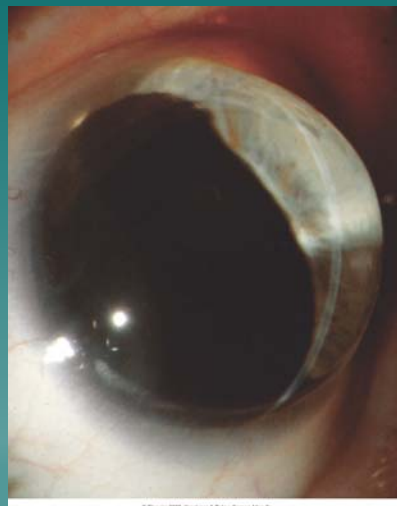
## ALKP PRINCIPLE (Anterior Lamellar Keratoplasty)



## Large Diameter ALKP for Keratoglobus

### LARGE DIAMETER ANTERIOR LAMELLAR KERATOPLASTY

Keratoglobus



## LARGE DIAMETER ANTERIOR LAMELLAR KERATOPLASTY

### Keratoglobus

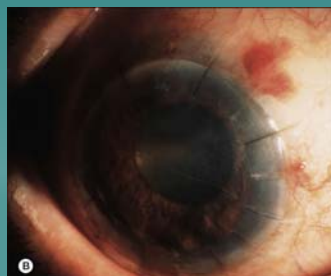
- ◆ D.G. 33yo, Ehlers Danlos Type V or VI (very rare, no aortic involvement)
  - Thinned to 5-10% residual stroma, limbus



## LARGE DIAMETER ANTERIOR LAMELLAR KERATOPLASTY

### Keratoglobus

- ◆ Too thin for riboflavin CXL
- ◆ Must preserve limbal stem cells: "tuck" behind Palisades of Vogt

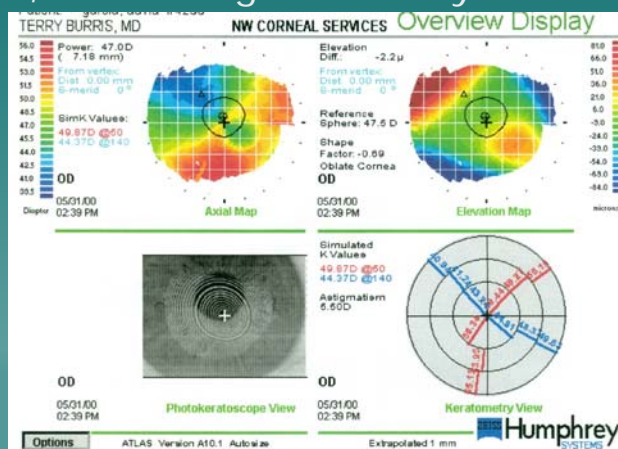




# LARGE DIAMETER ANTERIOR LAMELLAR KERATOPLASTY

Keratoglobus: D.G.: 33 yo wm, OD: 47 D cornea, 5.5 D irregular toricity

Preop



# LARGE DIAMETER ANTERIOR LAMELLAR KERATOPLASTY

Keratoglobus

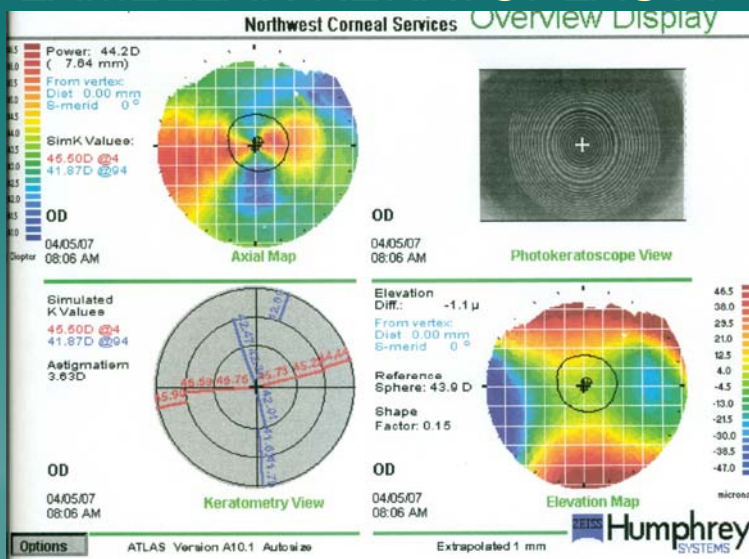
- ◆ D.G. 33yo, Ehlers Danlos Type V or VI





# LARGE DIAMETER ANTERIOR LAMELLAR KERATOPLASTY

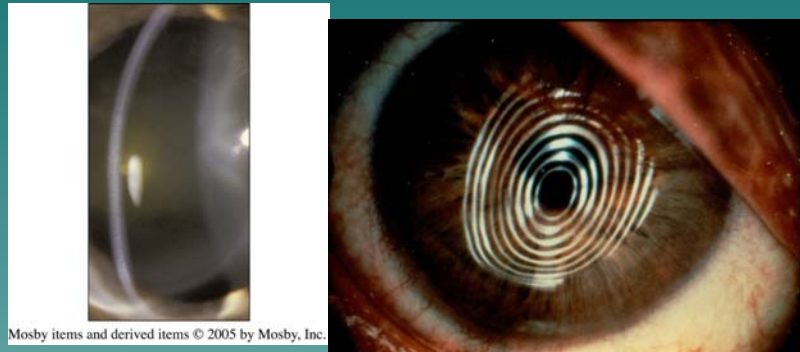
D.G.  
Postop  
43D  
3.6D cyl



## CRESCENTIC ALKP

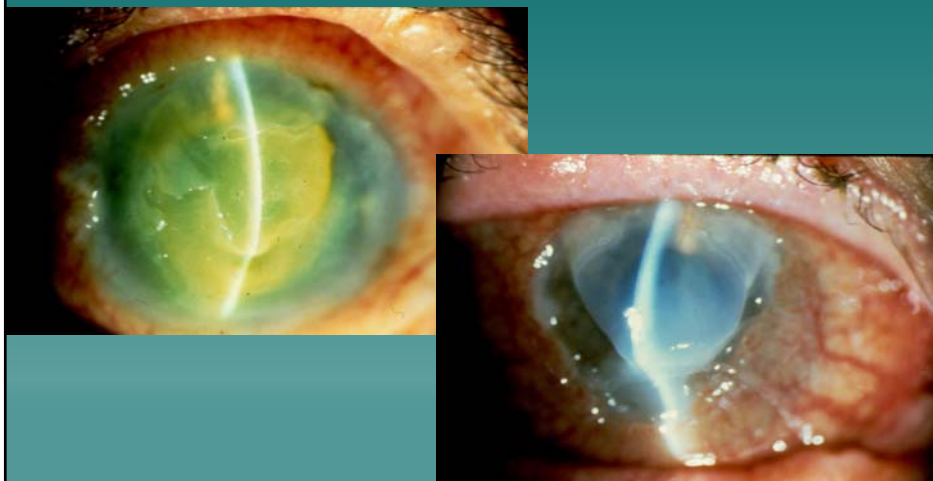
## Crescentic Tectonic ALKP: Indications

- ◆ Pellucid marginal degeneration



## Crescentic Tectonic ALKP: Indications

- ◆ Mooren's ulcer



## Crescentic Tectonic ALKP: Indications

- ◆ Rheumatoid melt



Mosby items and derived items © 2005 by Mosby, Inc.

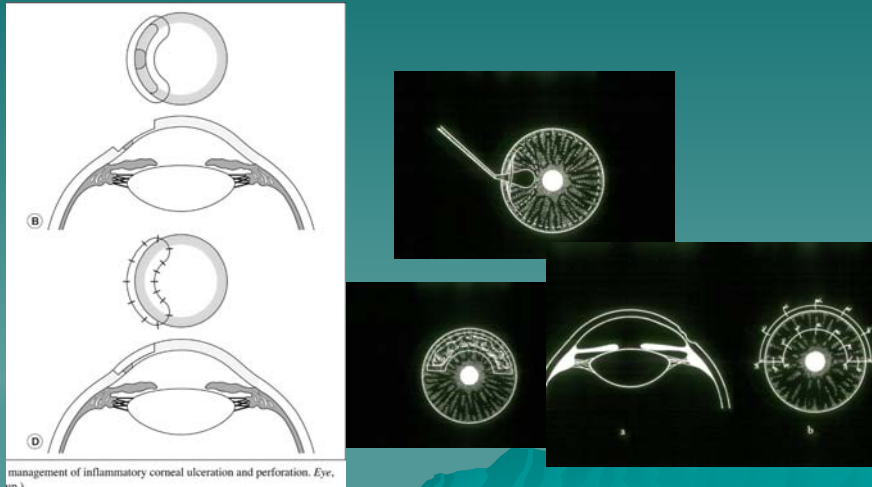
## Crescentic Tectonic ALKP: Indications

- ◆ Surgical misadventures



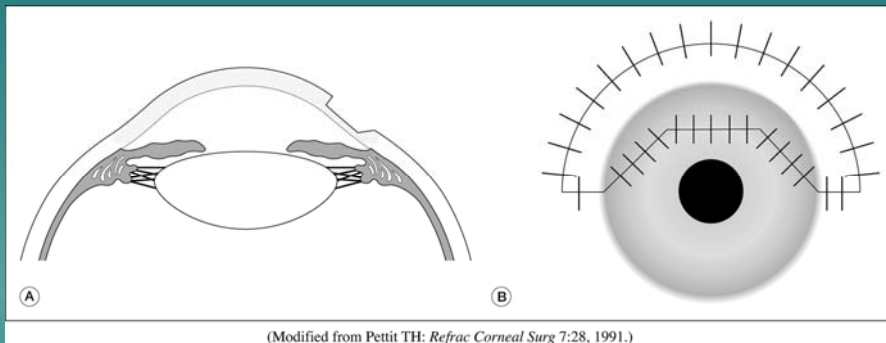
# Tectonic ALKP

## ◆ Crescentic Keratoplasty



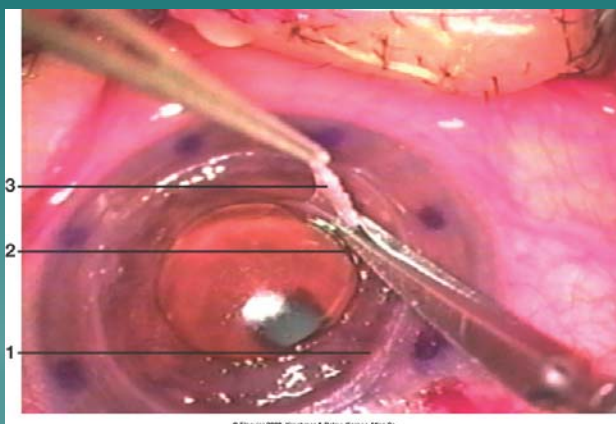
# Tectonic ALKP

## ◆ Crescentic Keratoplasty



## Tectonic ALKP

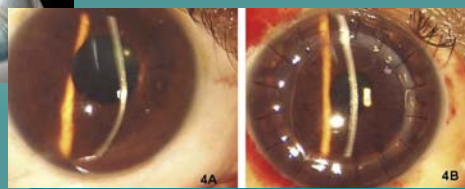
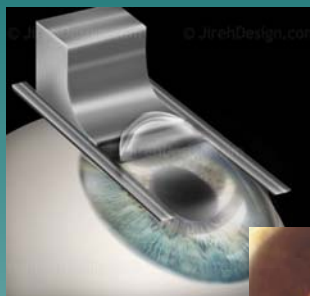
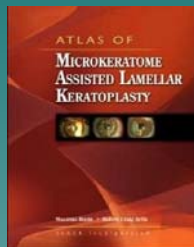
- ◆ Crescentic Keratoplasty



© Elsevier 2005. Wachtler & Palyi: Cornea Atlas 2a

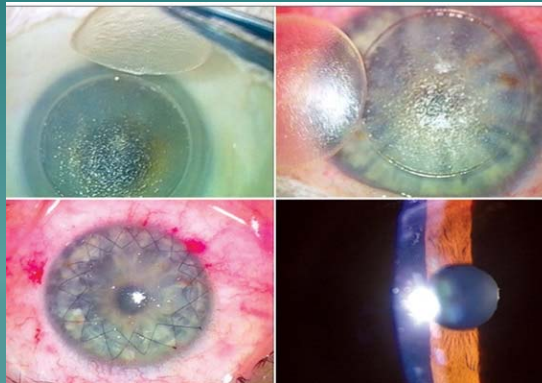
## ANTERIOR LAMELLAR/ TECTONIC (ALKP)

- ◆ Newer types
  - Microkeratome
    - ◆ Several keratome designs



## ANTERIOR LAMELLAR/ TECTONIC

- ◆ Newer Types
  - Femtosecond laser
  - ◆ Near infrared light



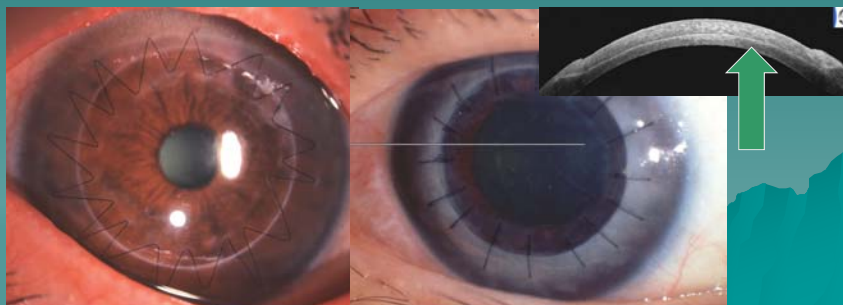
## Anterior Lamellar Keratoplasty

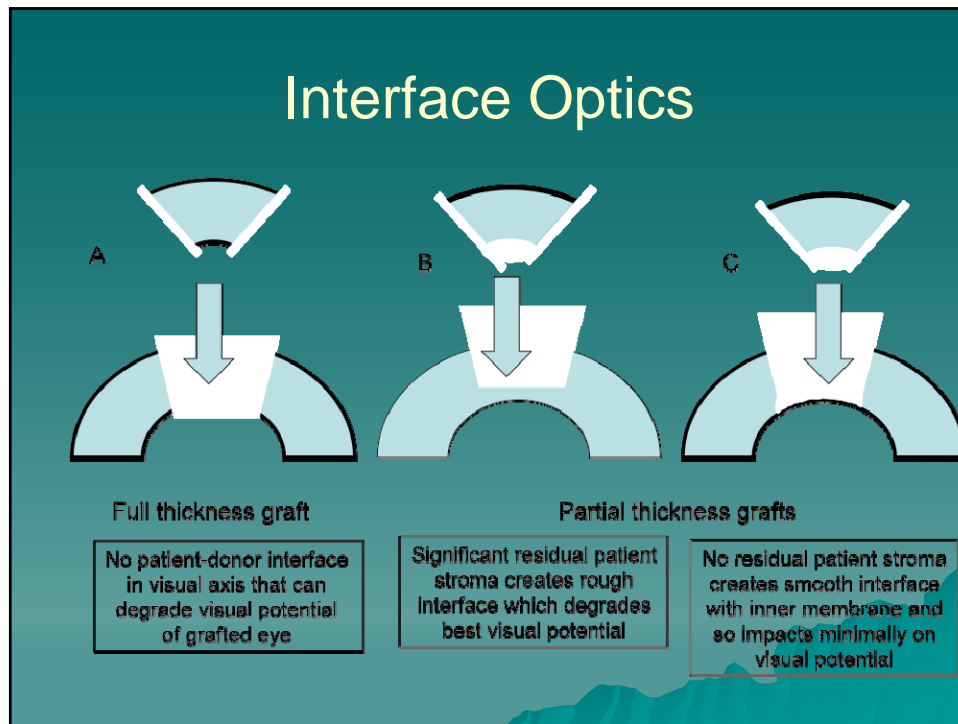
Traditional ALKP Advantage

- Relatively easy to perform

◆ Disadvantages

- Interface haze reduces visual outcome





## DEEP ANTERIOR LAMELLAR KERATOPLASTY (DALK)

### Advantages

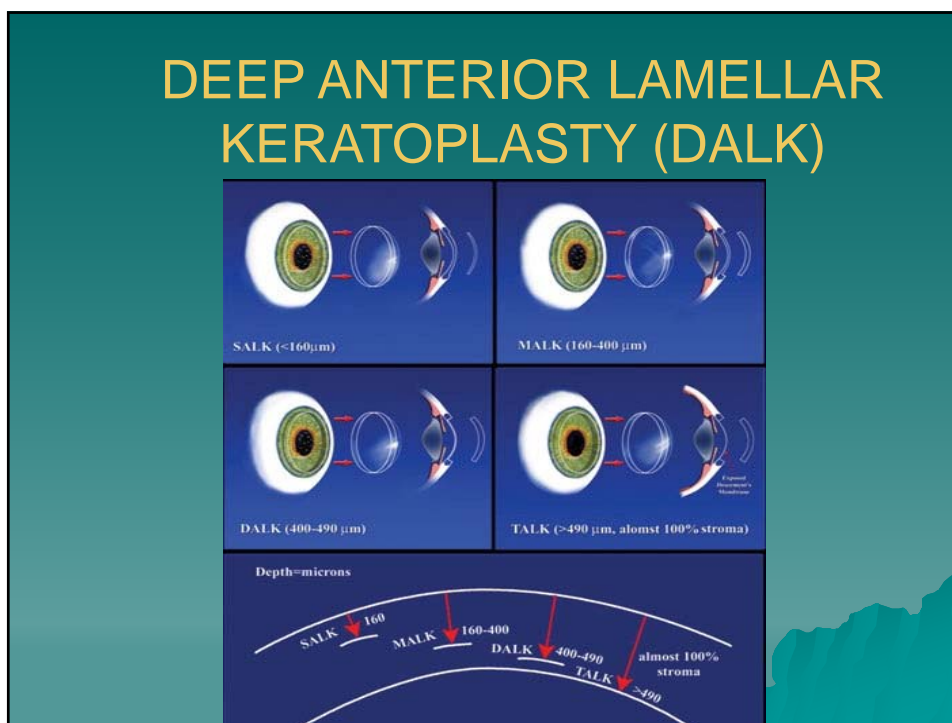
- ◆ Eliminates risk of endothelial graft rejection—less follow up once sutures out!
- ◆ less interface haze/ better vision potential
- ◆ Gaining popularity for keratoconus (vs PK)

### Disadvantages

- ◆ Recipient cornea must not be too thin
- ◆ No panstromal scarring
  - Descemet/ scar attachments cause perforation
- ◆ Time consuming
- ◆ Must be ready to convert to PK (back up corneal tissue!)



## DEEP ANTERIOR LAMELLAR KERATOPLASTY (DALK)



## CURRENT TREND: DALK IF POSSIBLE

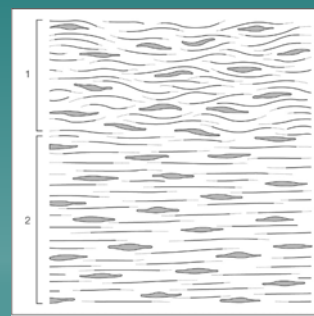
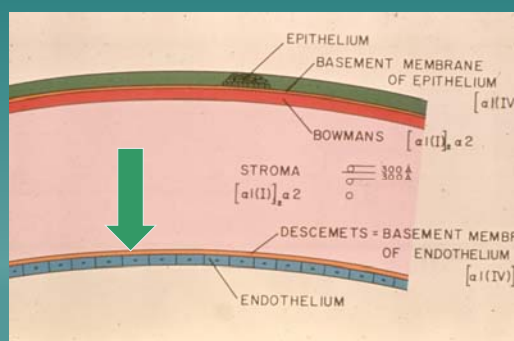
- ◆ If host endothelium is normal
  - Current trend toward more DALK and less Penetrating Keratoplasty (saves host endothelium)



## DALK

### Deep Anterior Lamellar Keratoplasty

- ◆ Indicated for Bowman's/anterior/ & *posterior* stromal replacement

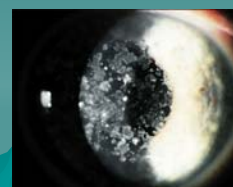
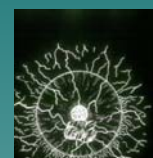
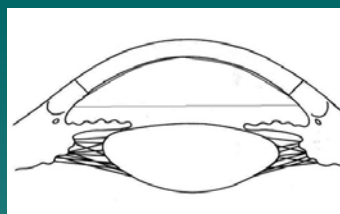


From Fine ES: *Ocular histology: a text and atlas*, ed. 2, Hagerstown, 1979, Harper & Row.

## DALK

### Indications:

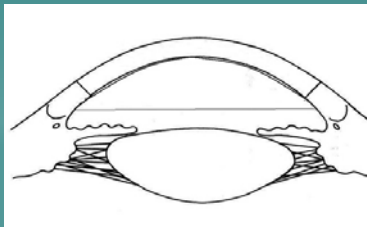
- ◆ Anterior, mid & certain posterior stromal scarring & vascularization
- ◆ Anterior corneal dystrophies
  - Anterior Basement membrane/
  - Reis Buckler's, Honeycomb
  - Granular
  - Lattice
  - Macular
- ◆ Keratoconus
- ◆ Post Lasik Ectasia



## DALK (Deep Anterior Lamellar Keratoplasty)

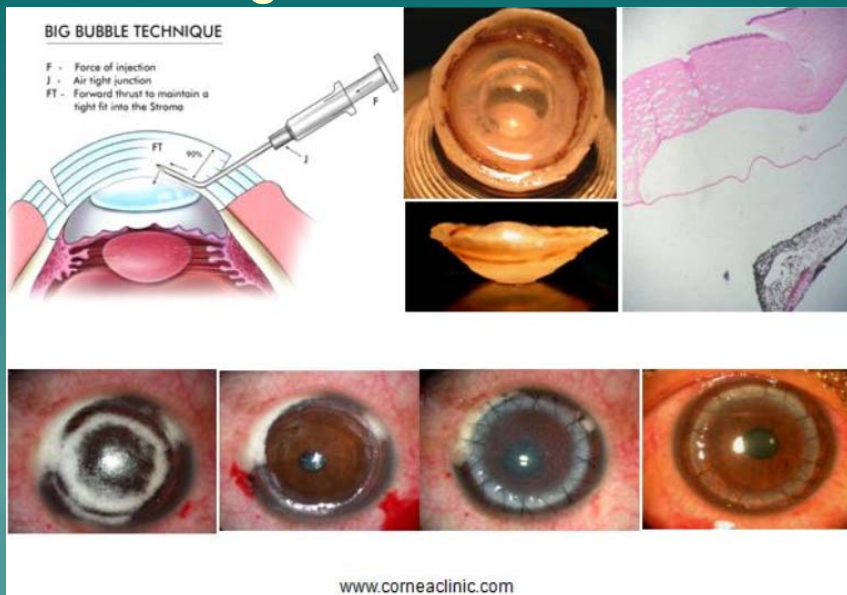
DALK:

- ◆ Historically inadequate techniques for preservation of Descemet's & endothelium with DALK
- ◆ Perforations were frequent

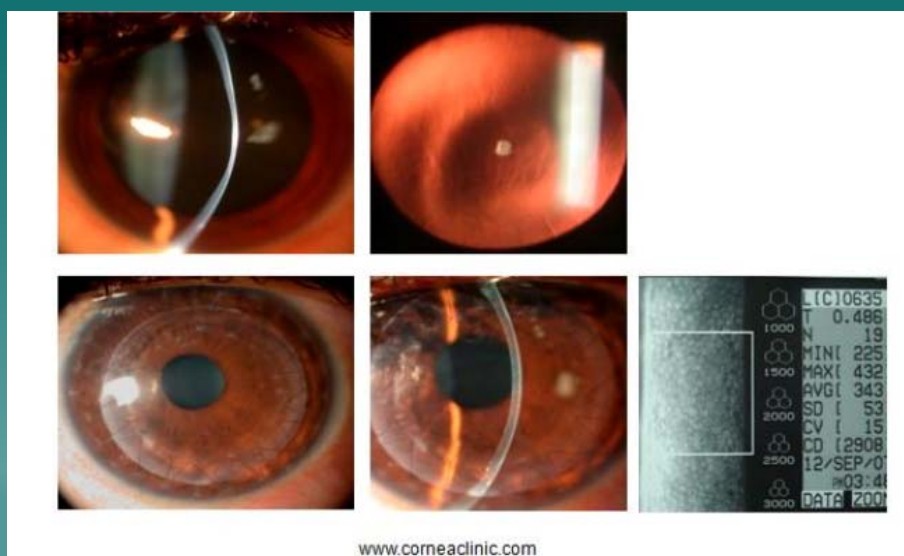


- ◆ I don't know what the problem is, but I am sure it can be solved without resorting to violence  
--Arnold Schwarzenegger (*Twins*)

# Big Bubble DALK



# Big Bubble DALK



## Donor Tissue for ALK/ DALK

- ◆ Traditionally fresh whole globe or short term preserved cornea
  - Generally use tissue without adequate endothelial cell counts for endothelial grafting
- ◆ DALK tissue: surgeon simply strips endothelium from donor



## ALK: Eye Bank Can “Precut” Patch Tissue to Thickness Required





Precut Lamellar Graft Tissue  
Delivered to O.R.



## Donor Tissue for ALK

- ◆ Traditionally fresh whole globe or short term preserved cornea
  - Generally use tissue without adequate endothelial cell counts for endothelial grafting
- ◆ Recently new Halo "sterile cornea" Portland OR



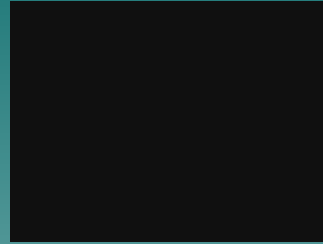
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## HALO STERILE CORNEA

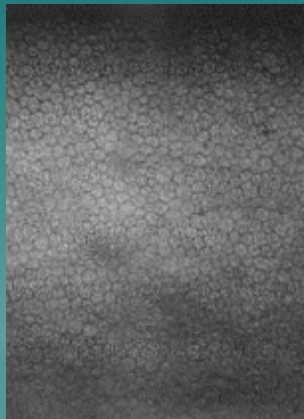
- ◆ Off the shelf immediate availability
- ◆ Sterile!
- ◆ Normal structural strength
- ◆ No viable cells, e.g. endothelium, keratocytes
- ◆ Potentially less risk of rejection



◆ DALK Surgery



Endothelial Replacement  
Endothelial Keratoplasty (EK)





## Endothelial Replacement Endothelial Keratoplasty (EK)

Reasons for EK:

- ◆ Eye is **stronger**, resistant to injury
- ◆ Healing time significantly **shorter**
  - Quicker return to referring eye doctor
- ◆ Visual recovery **faster**
  - Appeals to younger patients
  - Appeals to older patients (~1 yr vs 8 years)
- ◆ Minimal **suture** use; suture related complications rare
- ◆ Minimal change in **refractive error**—return to spectacle correction for BCVA

## Endothelial Replacement Endothelial Keratoplasty (EK)

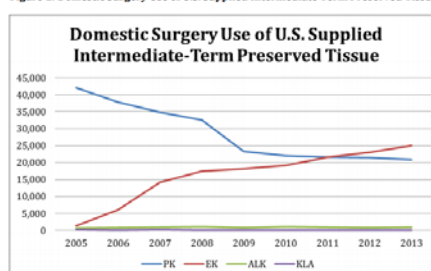
- ◆ DLEK (Deep Lamellar Endothelial Keratoplasty)—Now rarely used
- ◆ DSEK/DSEAEC: Descemet's Stripping (Automated) Endothelial Keratoplasty
  - Most frequent EK technique
- ◆ DMEK/DMAEK (Descemet's Membrane (Automated) Endothelial Keratoplasty)
  - Gaining use



## Endothelial Replacement Endothelial Keratoplasty (EK)

- ◆ 2012/2013 more EK's than PK's
- ◆ 24,000 DSEK/DSAEK
- ◆ ~ 1500 DMEK  
(EBAA 2013)

Figure 1: Domestic Surgery Use of U.S. Supplied Intermediate Term Preserved Tissues



The frequency of PK, EK and ALK use is shown in Figure 2: 2011-2013 Domestic PK vs. EK vs. DALK. The number of DMEK procedures has more than doubled (1,522, up 103.5%), and figures 3 (2011-2013 Domestic DSEK trend) and 4 (2011-2013 Domestic DMEK Trend) suggest increased interest in DMEK as an endothelial keratoplasty procedure.

## DSAEK

- ◆ Descemet's stripping automated endothelial keratoplasty
- ◆ Technically easier than DLEK
- ◆ May be performed with "pre-cut" donor tissue from eye bank saving OR time



## DSAEK PROCEDURE

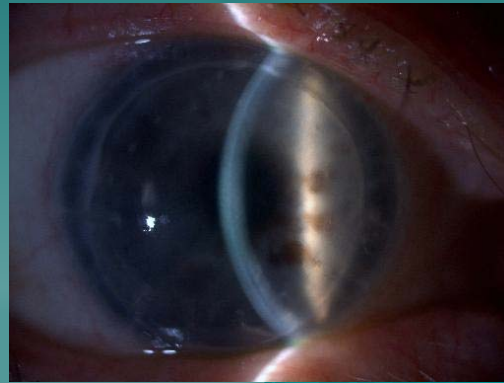


PK: rejected graft  
--Now an "easy" solution!

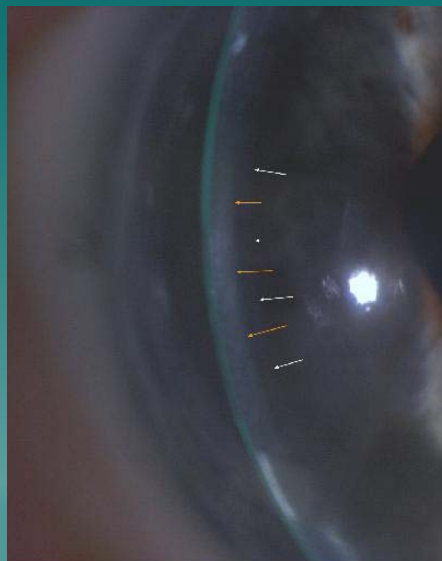


## PK: rejected graft—Candidate for DSAEK

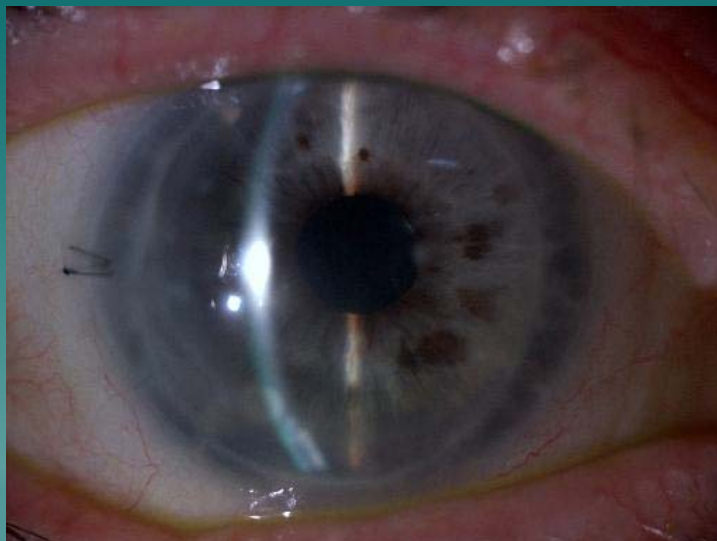
- ◆ Stromal edema not too chronic
- ◆ Good pre-rejection Va, VF & topography



## DSEK: clearing graft



## DSEK: clearing graft



## DMEK

- ◆ Descemet's membrane endothelial keratoplasty—
  - Beginning of the last *surgical* frontier?




## ENDOTHELIAL KERATOPLASTY

- ◆ Descemet membrane endothelial keratoplasty (DMEK)
  - Descemet's stripped from recipient as in DSAEK
  - Donor Descemet's prepared by "big bubble" technique (in O.R. or Eye Bank) or "scuba" technique
  - Descemet's placed on "carrier" ring or rolled into a "shooter"
  - Injected into AC and tediously unfurled
  - Air bubble injected

## ENDOTHELIAL KERATOPLASTY

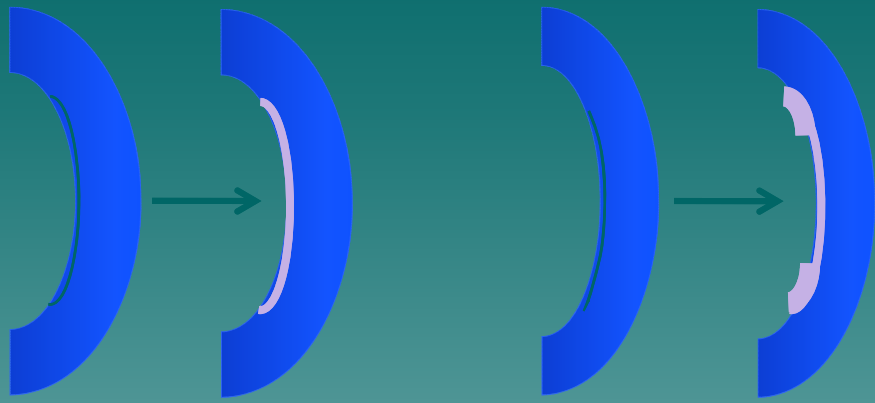
- ◆ DMEK Advantages:
  - Descemet's may stick better than donor disk of DSEK/DSAEK—so far NOT
  - May choose to transplant Fuchs patients at an earlier stage
  - Virtually "zero" refractive error change
- ◆ DMEK Disadvantages
  - Technically difficult to prepare donor
  - Technically difficult to unfurl donor in the anterior chamber
  - May take week(s) to adhere

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## New Directions in Eye Banking DMEK/DMAEK Preparation

Chris Stoeger, CEBT, CTBS


### DMEK/DMAEK: *The final frontier?*



**DMEK: Only Descemet's membrane transplanted**

**DMAEK: Thin rim of stroma**

Courtesy of Mark Terry, MD - Devers Eye Institute

 LIONS VISION GIFT

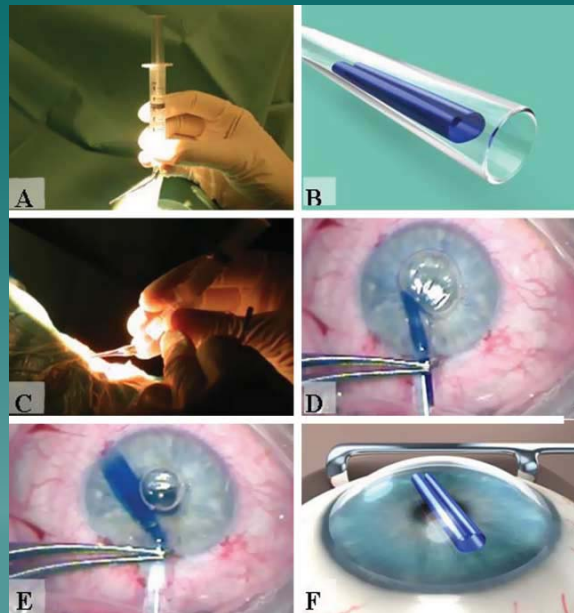
## Surgical Challenges with DMEK (and DMAEK)

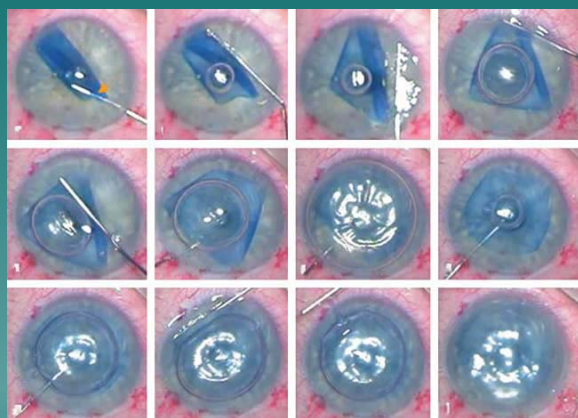
### ◆ DMEK:

- Risky harvesting of donor Descemet's membrane with risk of tearing the tissue (another donor eye may be needed!)
- Difficult unfolding and centering of "scroll" of donor tissue in the recipient anterior chamber
- Getting graft to adhere

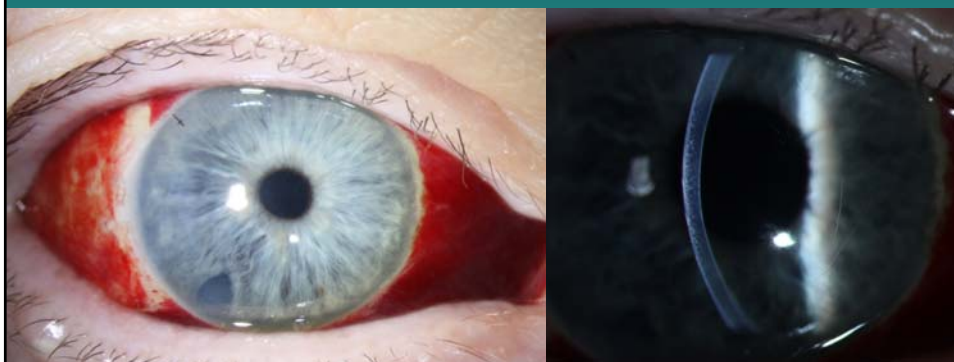


## DMEK Insertion





DMEK at 6 days post-op:  
Note clarity of graft and absence of visible graft edges



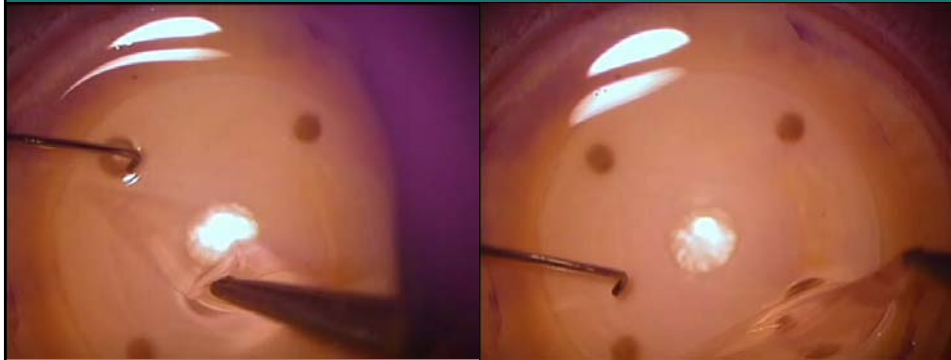
Courtesy of Mark Terry, MD Dever's Eye Institute

BSCVA = 20/30-





# DMEK Preparation



## ◆ DMEK



## Biggest DMEK challenge

- ◆ Graft attachment & need to rebubble/position patient for days

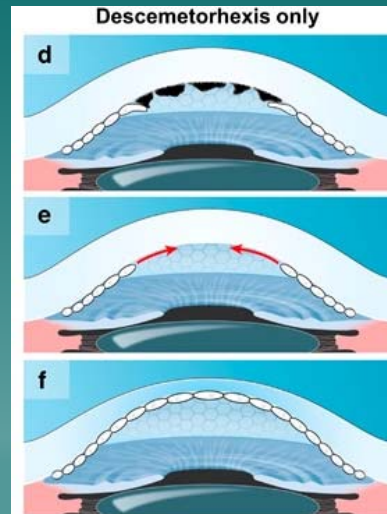


## DMEK...

- ◆ Descemet's membrane endothelial keratoplasty—
  - Beginning of the last *surgical* frontier?
  - Maybe not!
    - Central Descemet's stripping (3-4 mm)
    - +/-Rock inhibitor administration
    - May result in enough endothelial regeneration to restore vision (No graft!)
    - Fuchs may not be a *Dystrophy!*



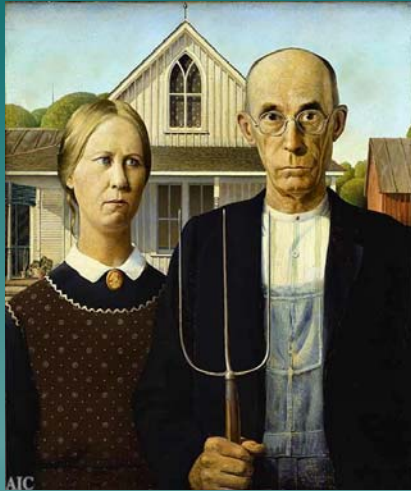
## Descemetorrhexis alone in select cases



Maybe less (surgery) is more!



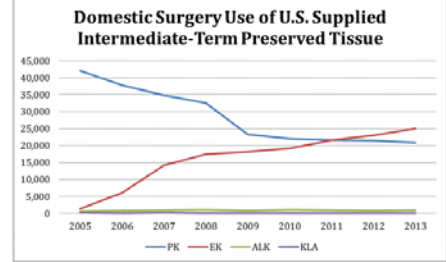
## Penetrating Keratoplasty (full thickness corneal graft)



American Gothic-Grant Wood 1930

- ◆ Still ~20 K performed in US per year

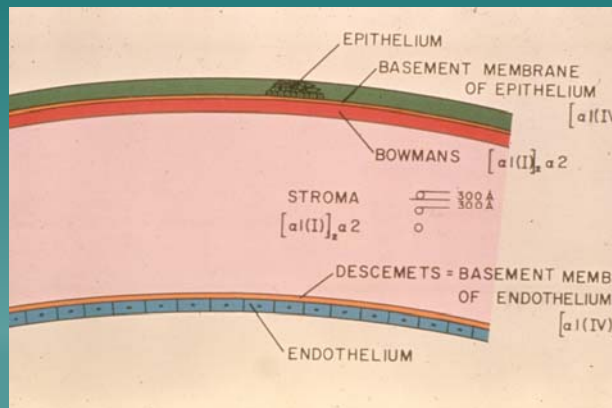
Figure 1: Domestic Surgery Use of U.S. Supplied Intermediate Term Preserved Tissues



The frequency of PK, EK and ALK use is shown in Figure 2: 2011-2013 Domestic PK vs. EK vs. DALK. The number of DMEK procedures has more than doubled (1,522, up 103.5%), and figures 3 (2011-2013 Domestic DSEK trend) and 4 (2011-2013 Domestic DMEK Trend) suggest increased interest in DMEK as an endothelial keratoplasty procedure.

## Penetrating Keratoplasty

- ◆ Full thickness corneal graft for all functional layers of the cornea



## Penetrating Keratoplasty

- ◆ First PK performed by Eduard Zirm, 1905, Moravia, for alkali burn



## Penetrating Keratoplasty

Indications:

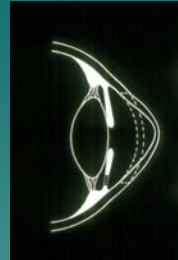
- ◆ Fuchs endothelial dystrophy  
– Chronic edema/ scarring
- ◆ Pseudophakic corneal edema/ bullous keratopathy



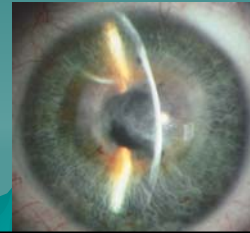
## Penetrating Keratoplasty

Indications:

- ◆ Keratoconus/  
Post-LASIK ectasia  
--with deep scarring



- ◆ Herpetic corneal scars



## Penetrating Keratoplasty

Indications:

- ◆ Traumatic scars



- ◆ Dystrophies



# Penetrating Keratoplasty

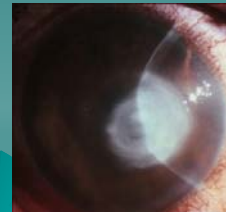
Indications:

- ◆ Congenital opacities e.g. Peter's anomaly

CHED



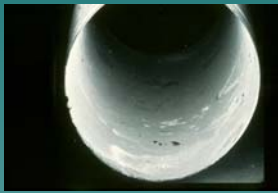
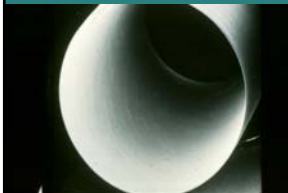
- ◆ Therapeutic: Non-responsive infective ulcers e.g. mycobacteria, fungus



# Penetrating Keratoplasty

Trephines

- ◆ Donor





# Penetrating Keratoplasty

Trephines

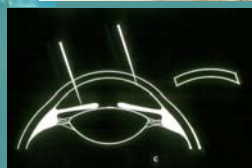
◆ Donor



# Penetrating Keratoplasty

Trephines

◆ Recipient

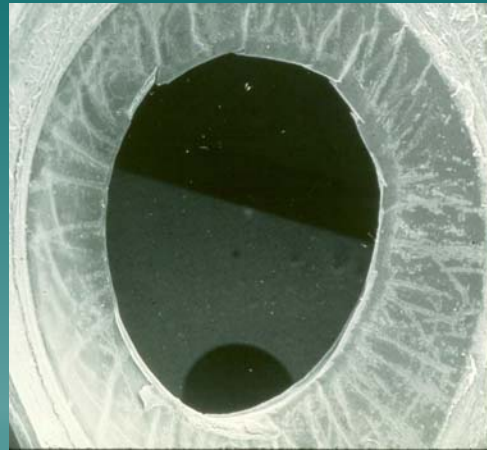




## Penetrating Keratoplasty

Trephines

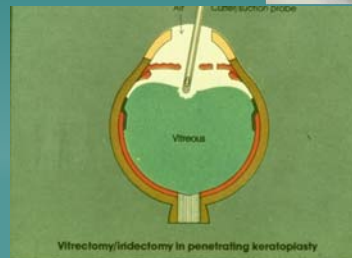
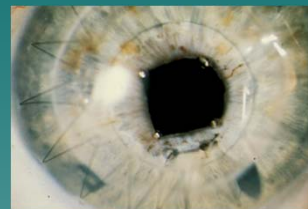
- ◆ Recipient



## Penetrating Keratoplasty

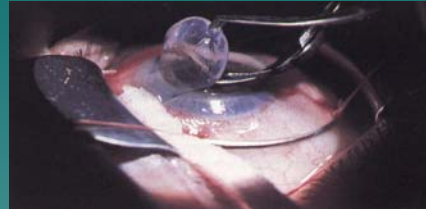
May be combined with

- ◆ Cataract surgery
- ◆ IOL removal/ exchange
- ◆ Vitrectomy



## Penetrating Keratoplasty

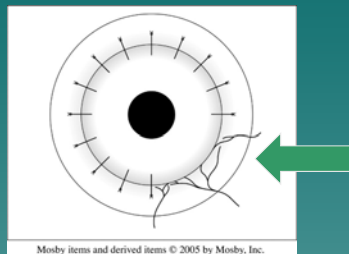
- ◆ Removal of recipient's cornea
- ◆ Donor cornea placement



## Penetrating Keratoplasty

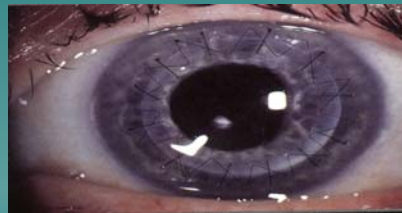
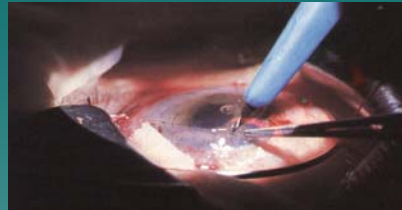
Suture techniques

- ◆ Interrupted
- ◆ Running



## Penetrating Keratoplasty

- ◆ Sutures placed
- ◆ Completed cornea transplant



## Penetrating Keratoplasty

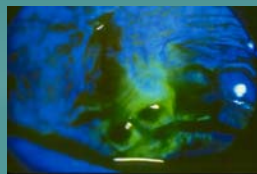
Numerous potential complications

- ◆ Wound problems associated with sutures:

Indolent erosions



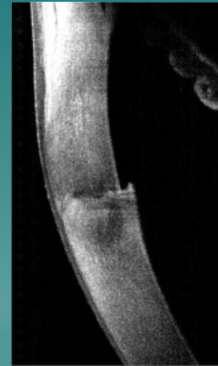
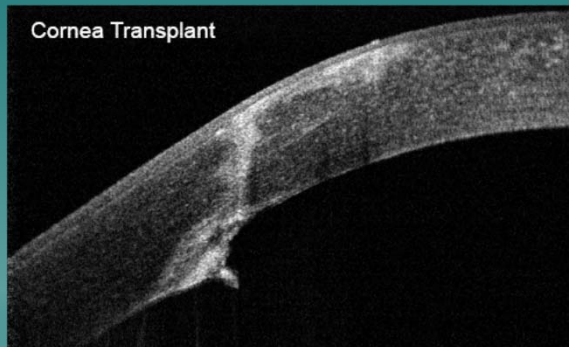
Wound leak



## Penetrating Keratoplasty

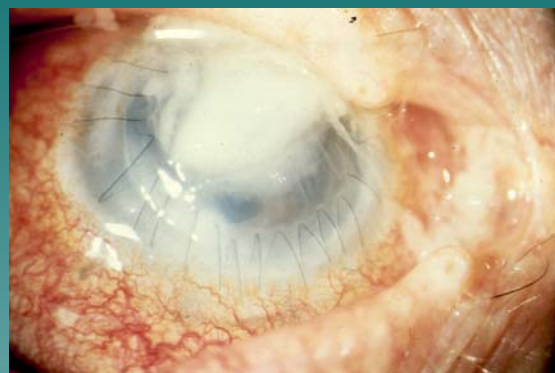
Numerous potential complications

- ◆ Wound problems/Wound mismatch



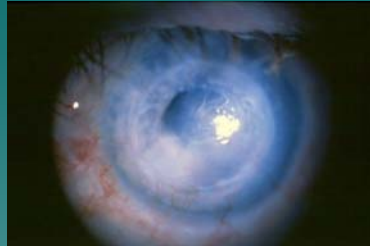
## Penetrating Keratoplasty

- ◆ Infection



## Penetrating Keratoplasty

- ◆ Graft failure

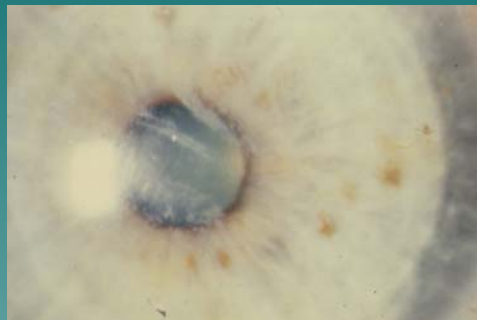


- ◆ Rejection



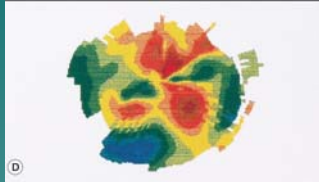
## Penetrating Keratoplasty

- ◆ Recurrence of pathology
  - dystrophies
  - keratoconus

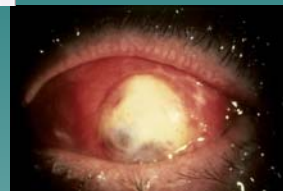


## Penetrating Keratoplasty

- ◆ High and Irregular Astigmatism



- ◆ Endophthalmitis



- ◆ ...etc; hence interest in lamellar surgery

## Status of Penetrating Keratoplasty?

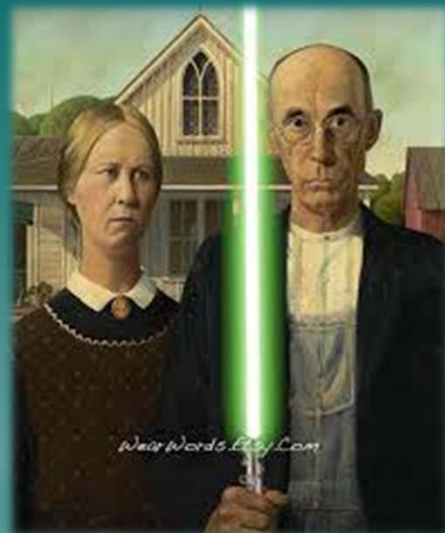


## Status of PK (Penetrating Keratoplasty) ?

- Major hurdles
  - ◆ Wound/ interface issues
    - Healing time
    - Suture complications
    - Increase terminal wound strength (>70%)
  - ◆ Topography: prolate/ non-astigmatic
  - ◆ Reduce rejection potential



## Femtosecond PKP





## Penetrating Keratoplasty (FPKP or FLAK)

### ◆ Femtosecond PK



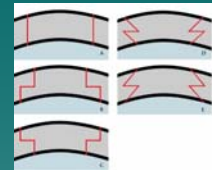
– Effort to reduce postop problems

- ◆ Improved wound architecture
- ◆ Greater wound strength
- ◆ More rapid wound healing
- ◆ Earlier suture removal

◆ But, Greater cost/ resources

## Penetrating Keratoplasty

### ◆ Femtosecond PK



Mushroom incision profile



The mushroom-shaped incision preserves more host endothelium than the traditional trephine approach.<sup>1</sup>

Top-hat incision profile



The top-hat-shaped incision allows for the transplantation of large endothelial surfaces.<sup>1</sup>

Zig-zag incision profile



The zig-zag-shaped incision provides a smooth transition between host and donor tissue and allows for a hermetic wound seal.<sup>1</sup>



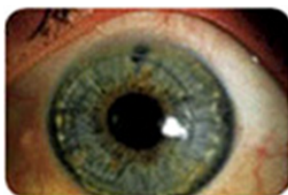
## Penetrating Keratoplasty

### ◆ Femtosecond Laser PK (FLAK)

1 week after surgery



3 months after surgery



6 months after surgery



## Penetrating Keratoplasty

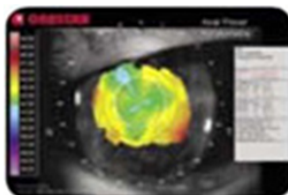
### ◆ Femtosecond PK (FLAK)

Zig-zag incision



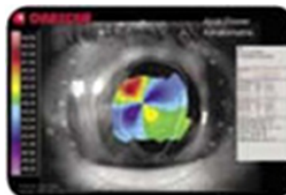
The zig-zag-shaped incision has shown a smooth corneal contour immediately after surgery, with less distortion of the corneal optics and less astigmatism.<sup>1</sup>

IEK 3 months after surgery



IEK result at 3 months after surgery = 0.5 diopter of astigmatism.<sup>1</sup>

Trepphine 1 year after surgery



Typical result with standard trephine-cut PKP at 1 year after surgery = 8 diopters.<sup>1</sup>

## Lecture Outline

- ◆ Tissue glue Advance
- ◆ Management of OSSN
- ◆ Corneal Transplantation: Selected techniques and advances
- ◆ **Surgical Options for Keratoconus**

## Surgical Management of Keratoconus: A new paradigm?

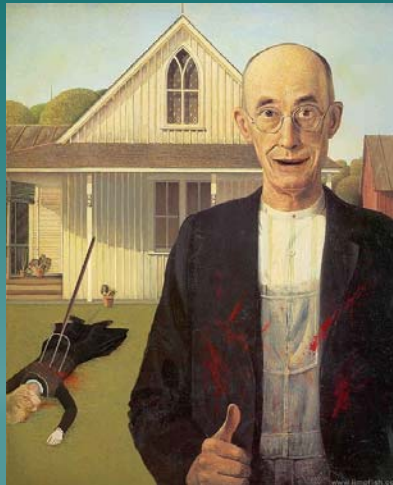


## Surgical Options for Keratoconus

- ◆ Corneal Cross-linking (UVA-riboflavin collagen crosslinking)
- ◆ Rose Bengal-visible light crosslinking
- ◆ Intacs, often combined with CXL
- ◆ Anterior (ALK, DALK) and Penetrating Keratoplasty (PKP)

## Goal for Keratoconus

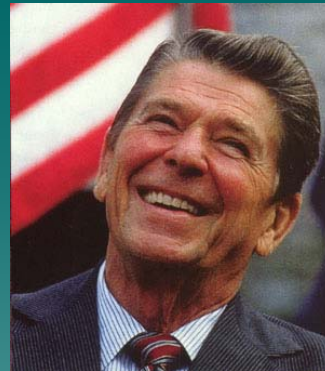
- ◆ Kill off need for corneal transplants!



## Corneal Cross-Linking (CXL)

- ◆ Paradigm shift for management of ectasias

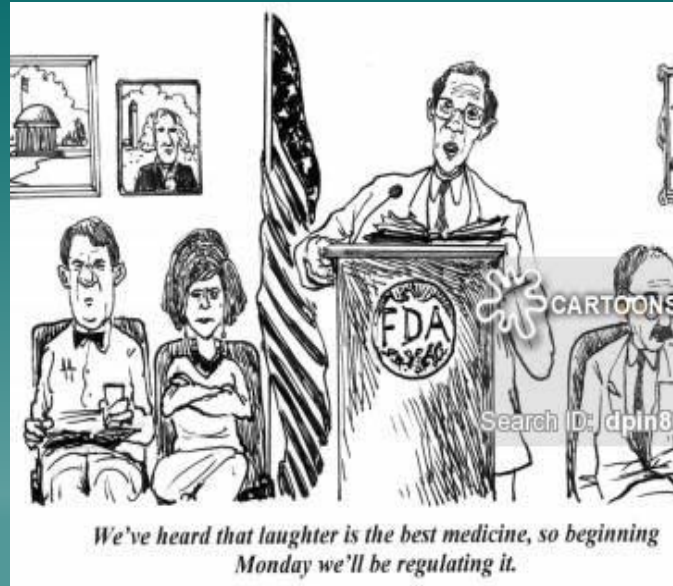
- Riboflavin/ UVA light
- Rose Bengal/ white light



- ◆ A government bureau is the nearest thing to eternal life we'll ever see on this earth

—Ronald Reagan (1911-2004)

## FDA



*You can always count on Americans to do the right thing—after they've tried everything else*

—Winston Churchill

## Grafts for Keratoconus & Ectasias

- ◆ Will grafts be a curiosity of the past?
  - Riboflavin UVA corneal cross-linking



## Riboflavin/UVA Crosslinking

- ◆ FDA-monitored clinical trials in progress, possible approval this year (Avedro, Inc)
- ◆ Multiple studies: may slow or stop keratoconus progression
- ◆ Flattening of up to 1D at 3-6 months
- ◆ Trend toward improved BCVA
- ◆ No major SEQ changes
- ◆ Less effective for higher K's
- ◆ Failure rate, loss of BSCVA, sterile infiltrates, scars, potential risks to be determined

Wittig-Silva et al 2008 Australia; Seiler et al 2009 Switzerland

## Riboflavin/UVA Crosslinking

- ◆ Cornea must be thicker than **300 microns** to prevent damage to endothelium
- ◆ New “standard of care” may be to treat keratoconus at ***first sign*** of ectasia
- ◆ Onset **teenage** years potentially most benefited from crosslinking
- ◆ New “epithelium on” techniques being studied
  - Greater ease of procedure
  - Greater comfort for patient

## Riboflavin/UVA Crosslinking

- ◆ Epithelium “off” procedure: 1:48



## Surgical Treatment of Keratoconus New Paradigm

- ◆ ICRS for early contact lens intolerance/ apical staining/ early scarring
- ◆ CXR after ICRS to inhibit further progression of keratoconus  
...Avoids corneal transplantation

## INTRACORNEAL RING SEGMENTS (ICRS) FOR KERATOCONUS



## Intacs History



**Gene Reynolds, O.D.**

1921 - 1994

© 2009 Addition Technology Inc.

- ◆ Oklahoma optometrist first conceptualized the idea in 1978
- ◆ One of the early medical champions of contact lenses in the U.S.
- ◆ Developed CorneaScope in late 1960s - led to today's topography

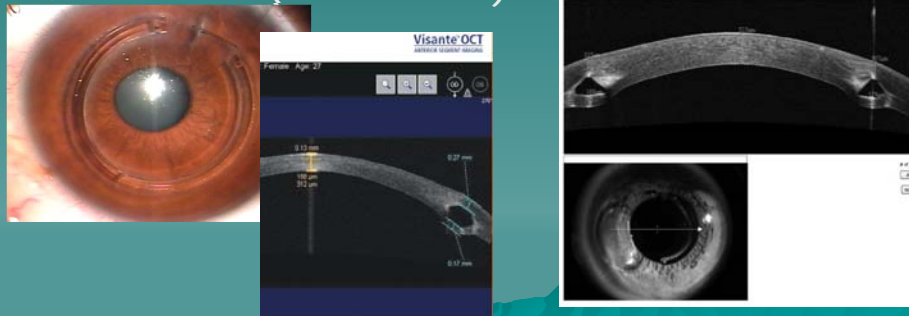
## Intacs History



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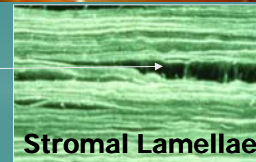
# ICRS

- ◆ INTACS (WORLDWIDE USE)
- ◆ FERRARA RINGS (NON-USA)
- ◆ OTHERS (NON-USA)



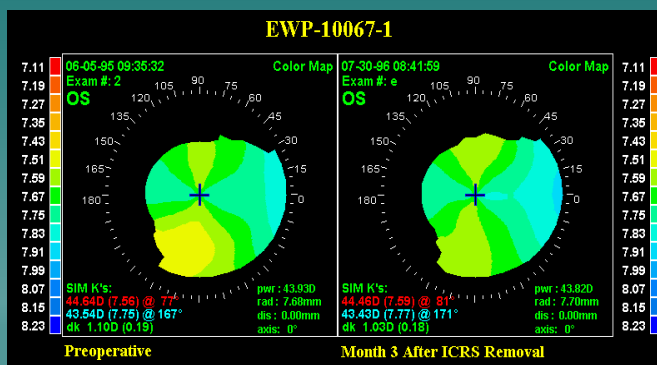
## Intacs Design Features

- 150° Arcs PMMA
- Precision Lathe-Cut to  $\pm 0.01\text{mm}$
- Hexagonal-Shaped Section of a Cone
- Inner Diameter = 6.8 mm
- Outer Diameter = 8.1 mm
- 2 Positioning Holes for Manipulation
- Intacs placement:
  - In peripheral cornea
  - Between stromal layers



## Intacs Flexibility

- Maintains Original Prolate Corneal Morphology
- Additive
  - Removable/Replaceable
- Large, Clear Central Optical Zone



## Indications for Intacs

Intacs for Keratoconus:

FDA IDE for:

Intended for Reduction or Elimination of Myopia and Astigmatism in Patients with Keratoconus who are:

- No Longer able to Achieve Adequate Vision with Contact Lenses or Spectacles
- Beginning to scar central cornea (punctate/swirling epitheliopathy)

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## Indications for Intacs

Intacs for Keratoconus:

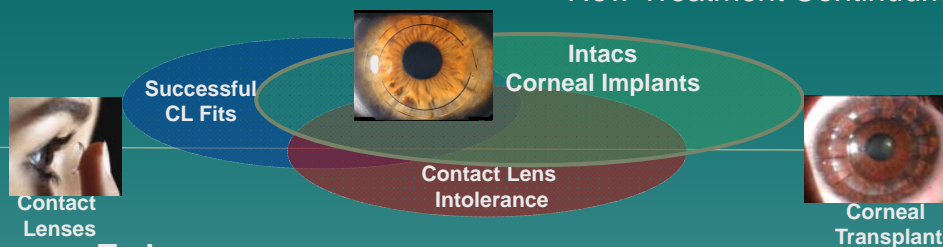
– FDA IDE:

- ◆ Goal: Restore Functional Vision/ ability to continue contact lens wear/ **Stop the apical scarring/** Potentially Defer PKP
  - ◆ 21 Years of Age or Older
  - ◆ Clear Central Corneas
  - ◆ Corneal Thickness of 450 Microns or Greater at the Proposed Incision Site
  - ◆ PKP or DALK as Remaining Option to Improve Functional Vision

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## Keratoconus Lifecycle

New Treatment Continuum



**Today:**

- Patient told they have Keratoconus or are Suspect
- **Patient Educated on Current and Future Options to Treat their Condition (Including Intacs)**
- Fit with Glasses or Contact Lenses
- Fit with Gas Perm or Specialty Contact Lenses **and told about Intacs**
- Re-Fit with Specialty Contact Lenses
- Becomes Contact Lens Intolerant
- Get Intacs
- **Potentially Defers** a Corneal Transplant

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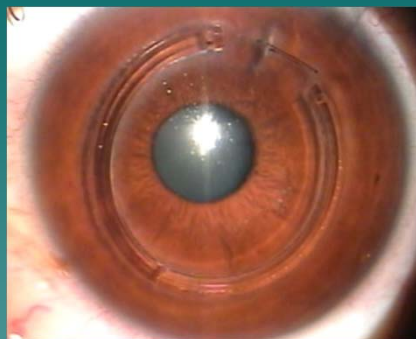
## New Keratoconus Lifecycle?

- ◆ Keratoconus diagnosed
- ◆ Corneal Cross-linking performed
  - Add Intacs if advanced disease
- ◆ Spectacles or Contact Lenses fit
- ◆ Corneal grafts (PK, DALK) for KCN will become increasingly rare

## Surgical Options for Advanced Keratoconus

- Intacs
- DALK
- Penetrating keratoplasty (PKP)

## Surgical Options for Advanced Keratoconus



**Intacs**

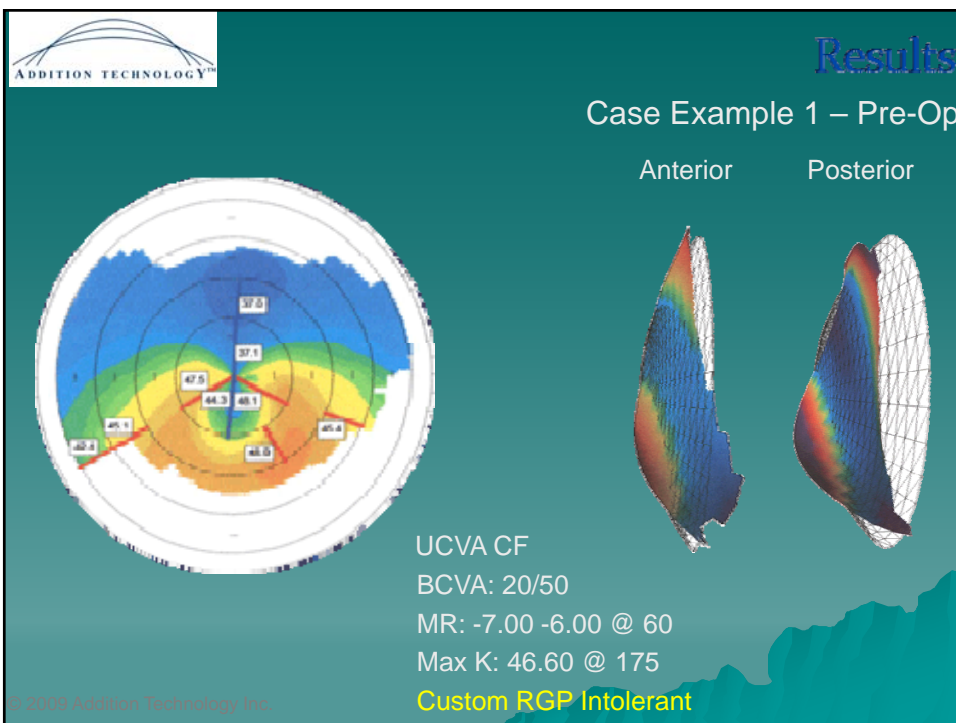
-0.75

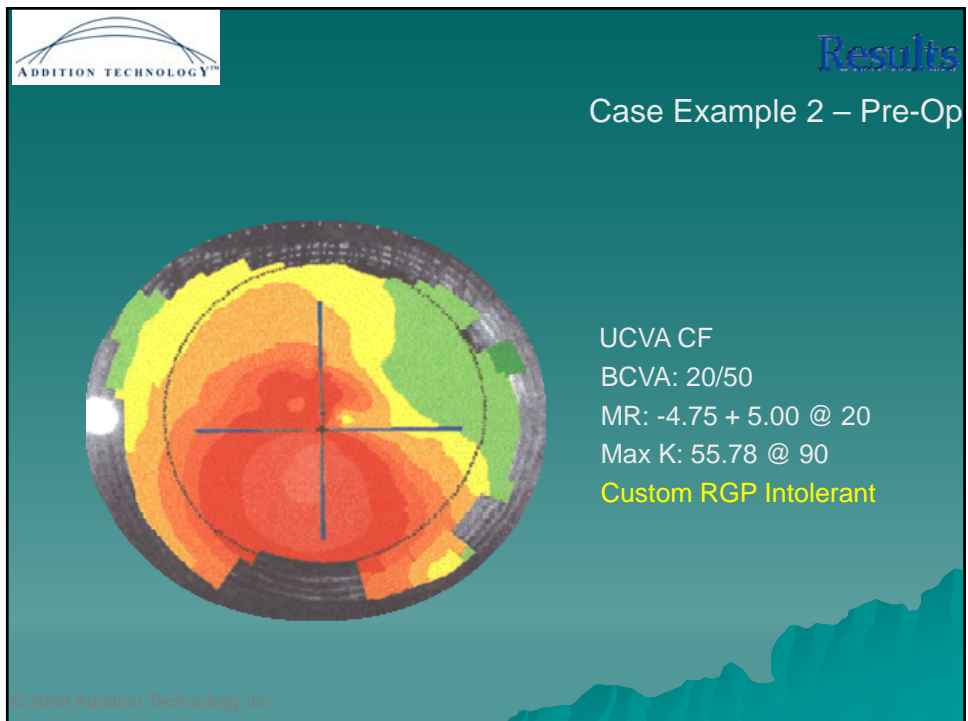
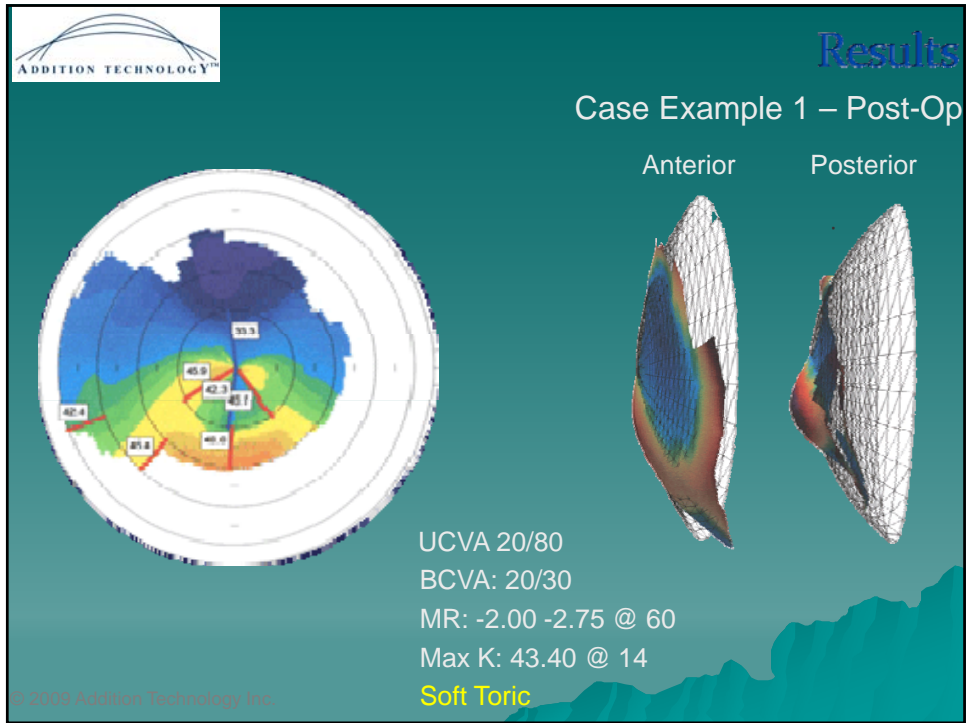


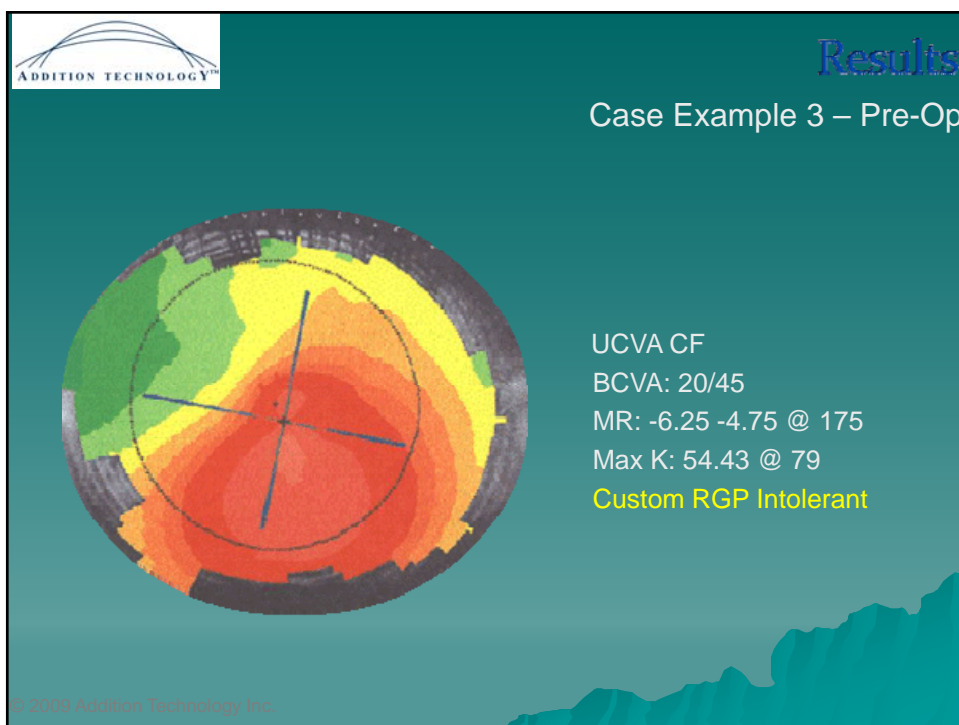
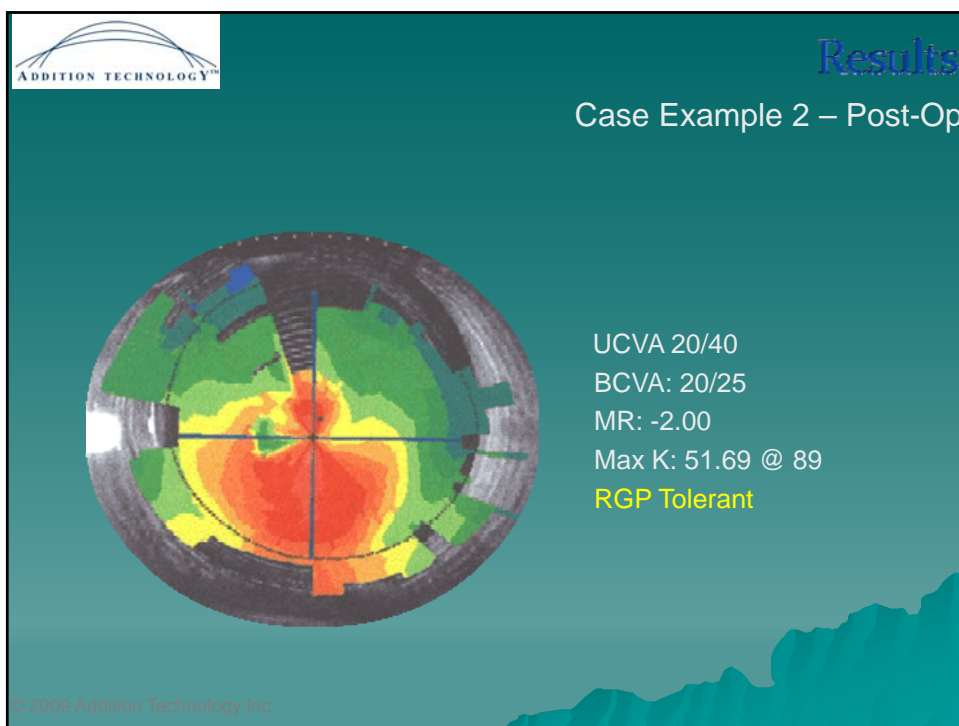
**Transplant**

+8.00 -2.00 X 180°

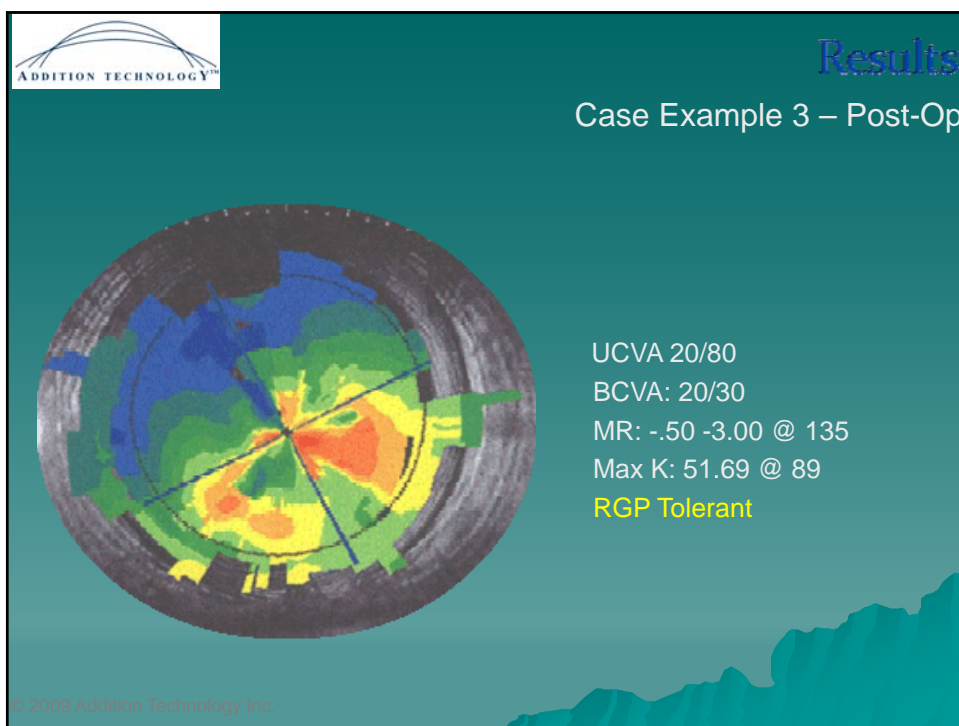
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## ICRS

- ◆ Femtosecond assisted Intacs procedure



ADDITION TECHNOLOGY™

Goal: Satisfied Patient



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## Results of ICRS and Riboflavin CXR for Keratoconus



- ◆ Progressive keratoconus in contact lens wearers/ relative intolerance:
  - Preponderance of papers support ICRS followed by riboflavin CXR to prevent further progression

## CORNEAL SURGERY UPDATE Summary

Take Home:

- ◆ Selective replacement of corneal lamellae more common
  - Faster healing and return to the primary eye care provider
  - Faster return to successful spectacle or contact lens wear
  - Often less chance of rejection
  - Better patient acceptance!
  - Can salvage previously rejected or failed PK's!

## CORNEAL SURGERY UPDATE Summary (cont)

- ◆ Surgical Management of Keratoconus moving away from corneal grafting:
  - The evolving paradigm is to
    - ◆ Perform **CXL** as soon as diagnosis of progression has been established, or young age of onset
    - ◆ Keep patients in spectacles, or contacts
    - ◆ **ICRS (Intacs)** to extend successful contact lens wear in more advanced disease



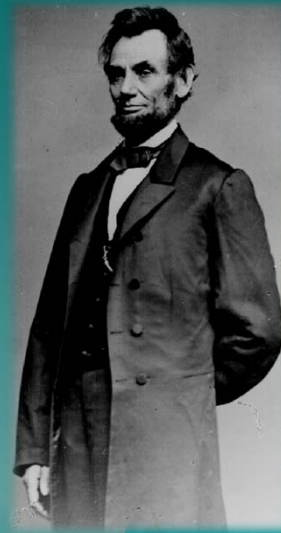
*Doctors are men who prescribe medicines of which they know little, to cure diseases of which they know less, in human beings of whom they know nothing.*

—Voltaire, 1694-1778

*French enlightenment writer, philosopher*

◆ And in the end, it is not the years in your life that count, it's the life in your years

—Abraham Lincoln, 16<sup>th</sup>  
US President (1809-863)





**Terry E. Burris, MD**

Northwest Corneal Services  
Portland, OR

Co- Medical Director, Lions VisionGift Oregon

Associate Clinical Professor of Ophthalmology  
Oregon Health Sciences University

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