Ocular Chemical Burn

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GUMS

- *From an epidemiological point of view, ocular chemical burns comprise up to 22% of all ocular injuries.*
- *Sulfuric acid is the most common agent responsible for acid burns.*
- *Ammonia is the most common agent leading to alkaline burns*

- *The difference in the ocular effects between acids and alkali resides in their mechanism of action.*

- *Acids and alkali cause coagulative and liquefactive necroses respectively .*

CLINICAL COURSE: GRADING AND STAGING

Table I Roper-Hall Classification for the Severity of Ocular Surface Burns[12]

Grade	Clinical Findings	Conjunctiva	Prognosis
	Cornea		
I	Corneal epithelial damage	No limbal ischemia	Good
II	Corneal haze with visible iris details	<1/3 limbal ischemia	Good
III	Total epithelial loss, stromal haze, with obscured iris details	1/3 to ½ limbal ischemia	Guarded
IV	Opaque cornea, with obscured iris and pupil	>1/2 limbal ischemia	Poor

Grading of severity of chemical injuries

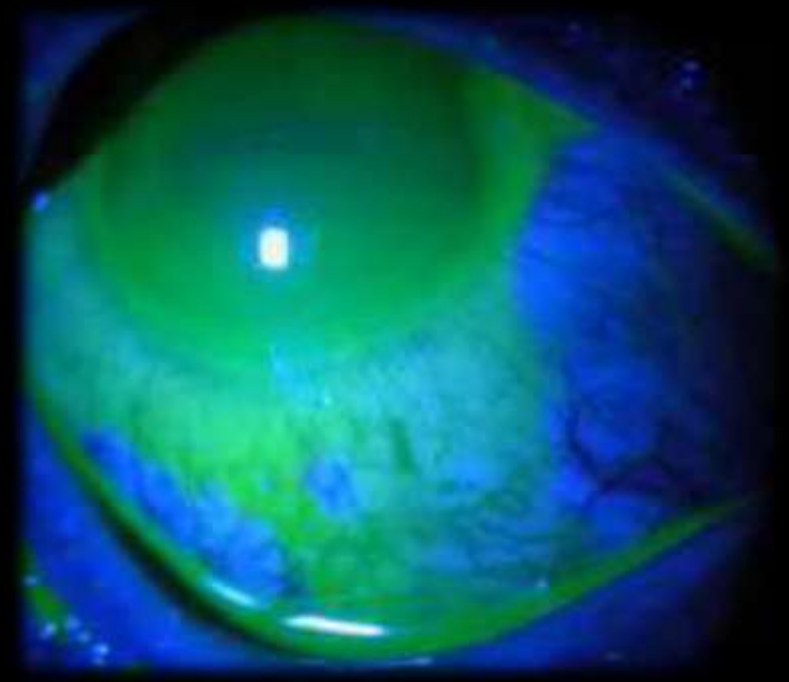
Grade I (excellent prognosis)

- Clear cornea
- No Limbal ischaemia

Grade II (good prognosis)	Grade III (guarded prognosis)	Grade IV (very poor prognosis)
		
• Cornea hazy but visible iris details • Limbal ischaemia < 1/3	• No iris details • Limbal ischaemia - 1/3 to 1/2	• Opaque cornea • Limbal ischaemia > 1/2

Table 2 Dua Classification for the Severity of Ocular Surface Burns[13]

Grade	Clock Hours of Limbal Involvement	Bulbar Conjunctival Involvement	Analog Scale	Prognosis
I	0	0%	0/0%	Very good
II	<3	<30%	0.1–3/1–29.9%	Good
III	>3–6	>30–50%	3.1–6/31–50%	Good
IV	>6–9	>50–75%	6.1–9/51–75%	Good to guarded
V	>9-<12	>75-<100%	9.1–11.9/75.1–99.9%	Guarded to poor
VI	12 (total)	100% (total)	12/100%	Very poor



MANAGEMENT STRATEGIES

✓ *Immediate (day 0)*

This is right after the exposure has occurred.

✓ *Acute (days 1–7)*

- *This is the 1st week following the immediate phase.*
- *In the acute stage, the limbal stem cell remnants try to repopulate the epithelial defects over denuded corneal stroma.*
- *This stage is crucial because tear-soluble proteolytic enzymes and immune-cell-derived enzymes may be conveyed to the stroma through epithelial defects and result in stromal thinning and perforation in later stages.*

✓*Early reparative (days 8–21)*

The 2nd and 3rd weeks following exposure.

This is the most common stage at which corneal ulcers or thinning are noted.

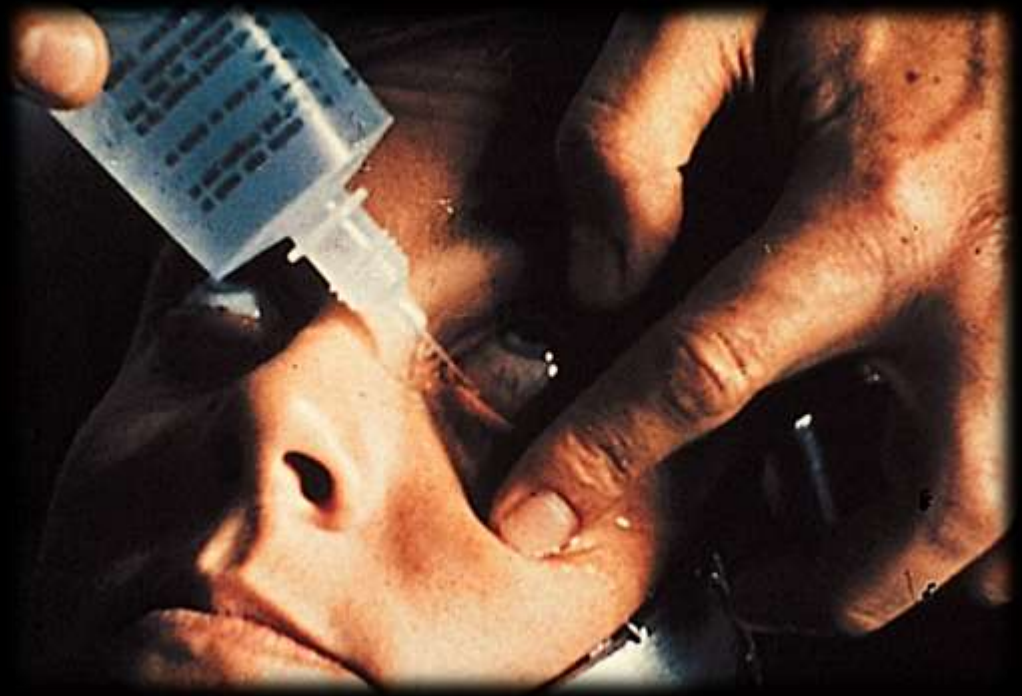
✓ *Late reparative(after day 21)*

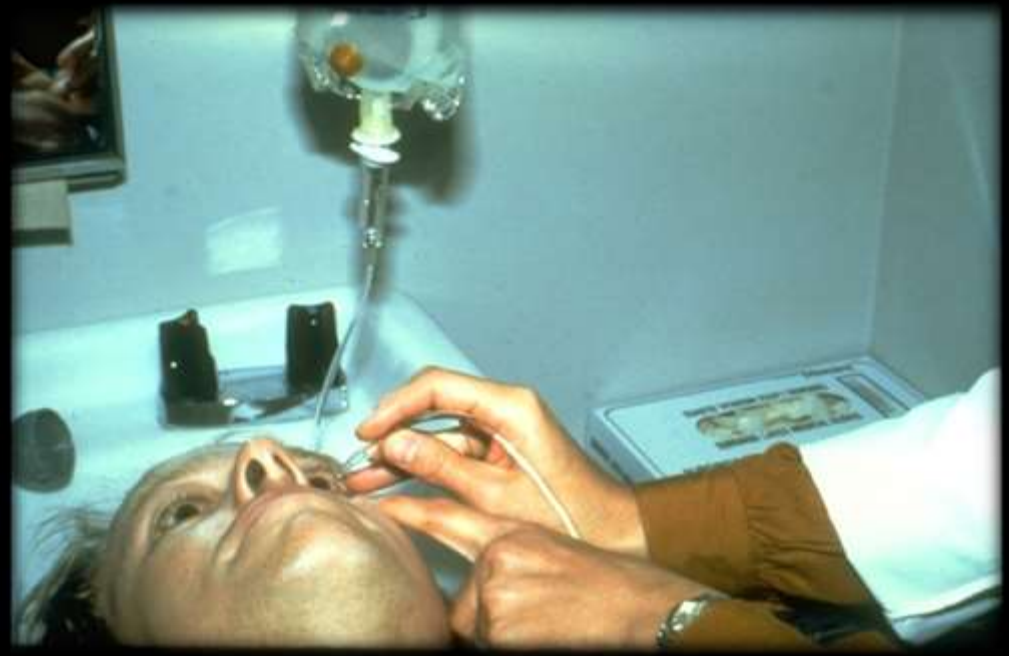
Except for those who had good prognostic features and who had managed appropriately, this stage represents the most severe complications of ocular chemical burns.

NON-OPERATIVE MANAGEMENT
MANAGEMENT OF IMMEDIATE STAGE

- *The very first step after exposure of the ocular surface to chemical agents is to institute continuous irrigation.*

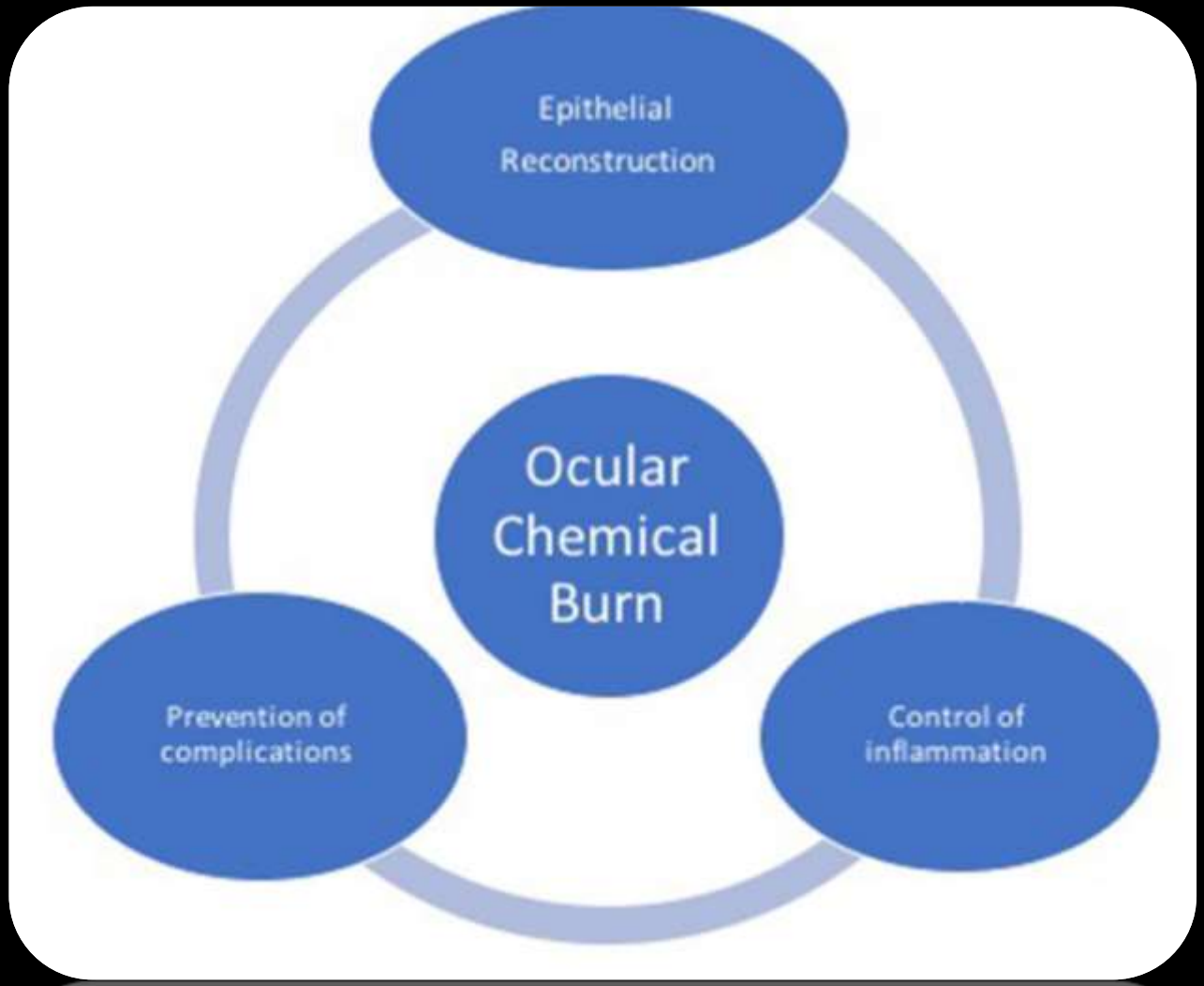
- *Immediate irrigation essential, preferably with saline or Ringer's lactate solution.*





Management strategies of ocular chemical burns have three facets:

- ✓ *Promotion of epithelialization*
- ✓ *Reduction of inflammation*
- ✓ *Prevention of complications*

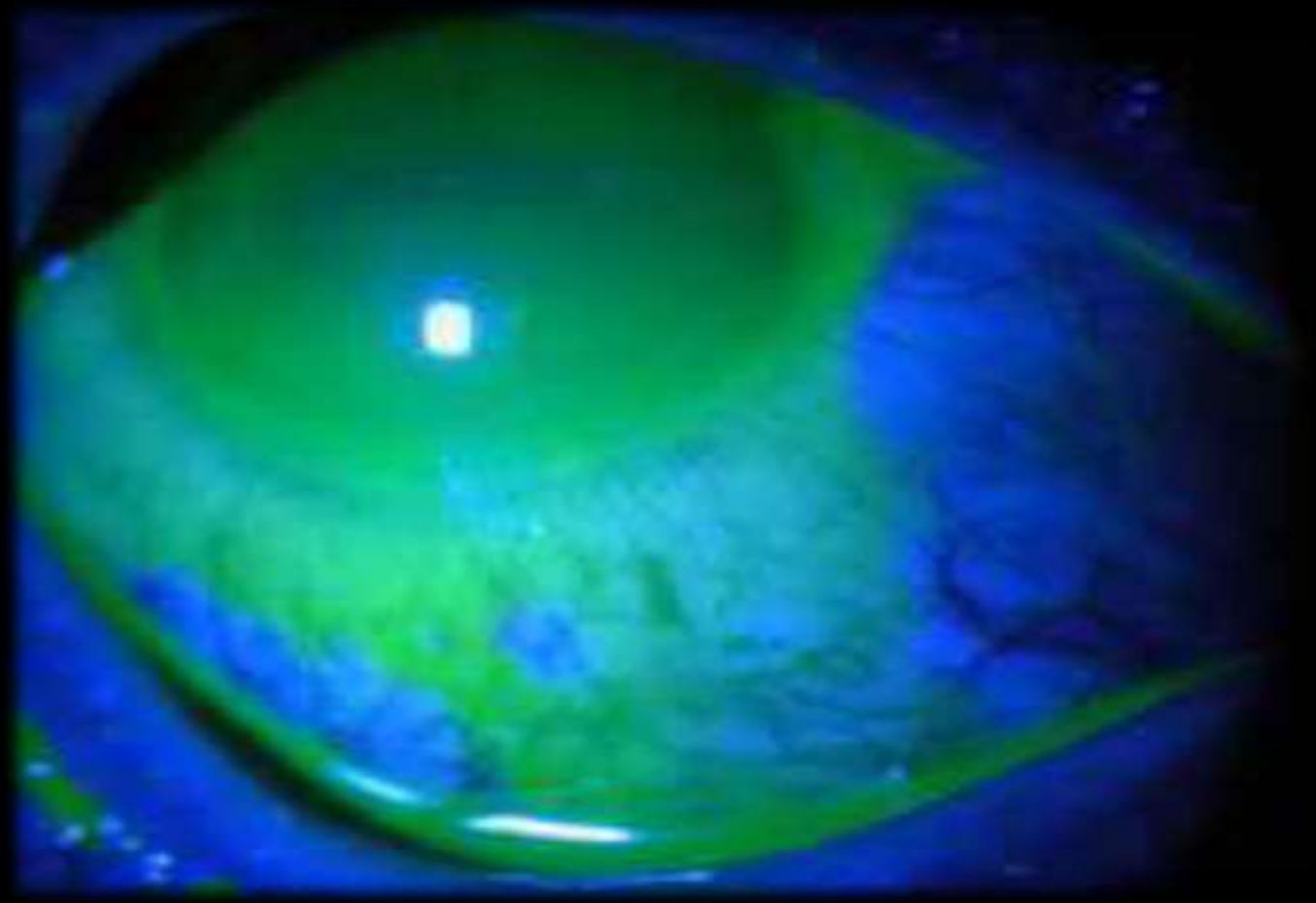


Stage (Days)	Suggested Intervention
Immediate (0)	**Prehospital:** - Start irrigation with any available clean solution as soon as possible* *hypertonic amphoteric solutions may be more beneficial **Hospital:** - Rapid assessment; - Remove any particulate material: lid eversion (even double eversion) may be necessary; - Continue copious irrigation* with frequent measurement of ocular surface pH with litmus paper; - Once stable normal pH is achieved, reassessment on slit lamp and document the severity according to Dua classificat *hypertonic amphoteric solutions may be more beneficial but patient discomfort is less with isotonic solutions
Acute (1–7) Early Reparative (8–21)	- Frequent topical corticosteroids irrespective of epithelial defects for at least 7 days* - Continue corticosteroids if epithelialization has been completed - Start frequent preservative-free artificial tears and continue throughout treatment - Start topical antibiotic (preservative-free formula is preferred) - Check IOP; start IOP lowering medications if elevated IOP is detected# - Start systemic tetracyclines and vitamin C - Start biological medications (AS or PRP) in grades III–VI Dua classification - Consider AMT (alternatively: PROKERA) in grades IV–VI Dua classification preferably in the first week - Consider Tenonplasty if scleral melting or ischemia is noted (more common in grades V–VI Dua classification) *In the presence of non-healing epithelial defects, steroids should be tapered after 10–14 days #Systemic agents may be preferred; Surgical interventions may be required in case of uncontrolled IOP
Late reparative (>21)	Treatment is directed at correction of complications: - Previous treatments are continued until stable ocular surface is ensured - DALK, PK, or KPro for visually debilitating stromal scars or endothelial failure - CLAU for unilateral LSCD; CLET, Ir-CLAL, and KLAL for bilateral LSCD - Symblepharon release with or without graft to restore external ocular movements - Forniceal and lid reconstruction

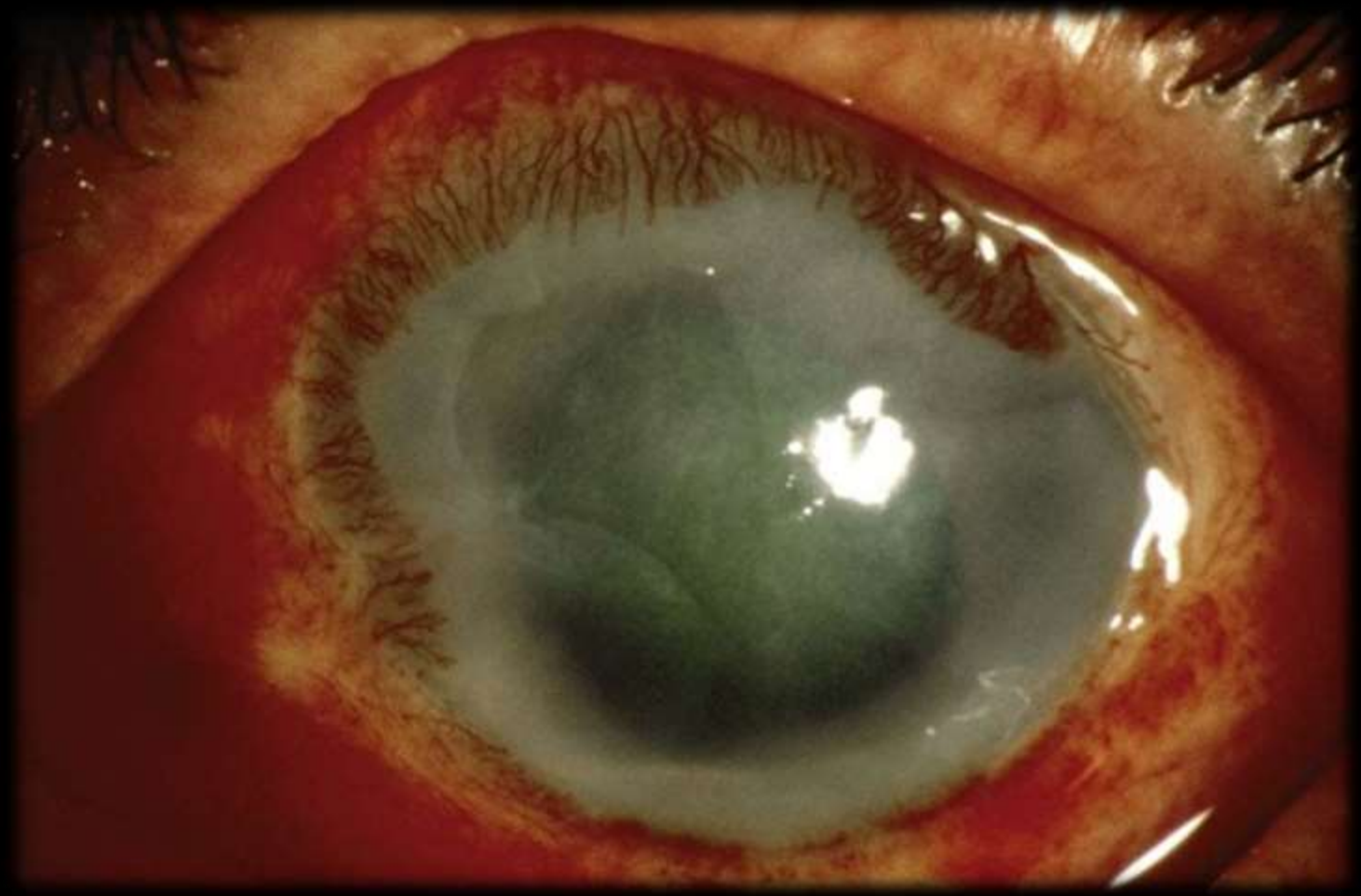
MANAGEMENT OF EPITHELIAL DEFECTS

- ✓ *Several topical and systemic medications have been proposed to promote re-epithelialization.*
- ✓ *Intact epithelium plays an important role in preserving stromal stability because it can effectively inhibit digestive enzymes from reaching underlying stroma.*
- ✓ *It is also critical in smoothing the ocular surface and expediting visual rehabilitation.*

- *Artificial Tears*
- *Fibronectin and Laminin*
- *Epidermal Growth Factor*
- *Retinoic Acid*
- *Hyaluronic Acid*
- *Tetracycline Medications*
- *N-Acetyl-Cysteine (NAC)*
- *Ascorbate*
- *Biological Medications*



- *Currently, it is recommended that all eyes with grades III to VI Dua's classification receive at least one type of biological eyedrops every 2 hours for a month starting in the acute stage and continued with slow taper until the inflammation has completely resolved.*



CONTROL OF INFLAMMATION

- *Corticosteroids*
- *Progesterone-Derivatives*
- *Citrate*
- *NSAIDs*

- *The benefits of topical corticosteroids in the acute stage of ocular chemical burn are invaluable.*

- *Steroids can prevent the reduction in the number of goblet cells, enhance the stability of the basement membrane and endothelial cells, reduce the migration of immune cells into the wound, and prevent degranulation of neutrophils.*

- *Conversely, prolonged treatment with corticosteroids has been associated with corneal and scleral sterile ulcers and melting because it interferes with collagen synthesis.*

PREVENTION OF COMPLICATIONS

- *Cornea with epithelial defects are especially vulnerable to a secondary infection.*

- *Measurement of intraocular pressure (IOP) is mandatory during the course of management.*

SURGICAL MANAGEMENT

- *Although surgical management is reserved for higher grades (generally grades III to VI Dua's classification).*

- *Instead, at any stage of the chemical burn, surgical interventions may be recommended to accelerate the healing process and to reduce the burden of complications*

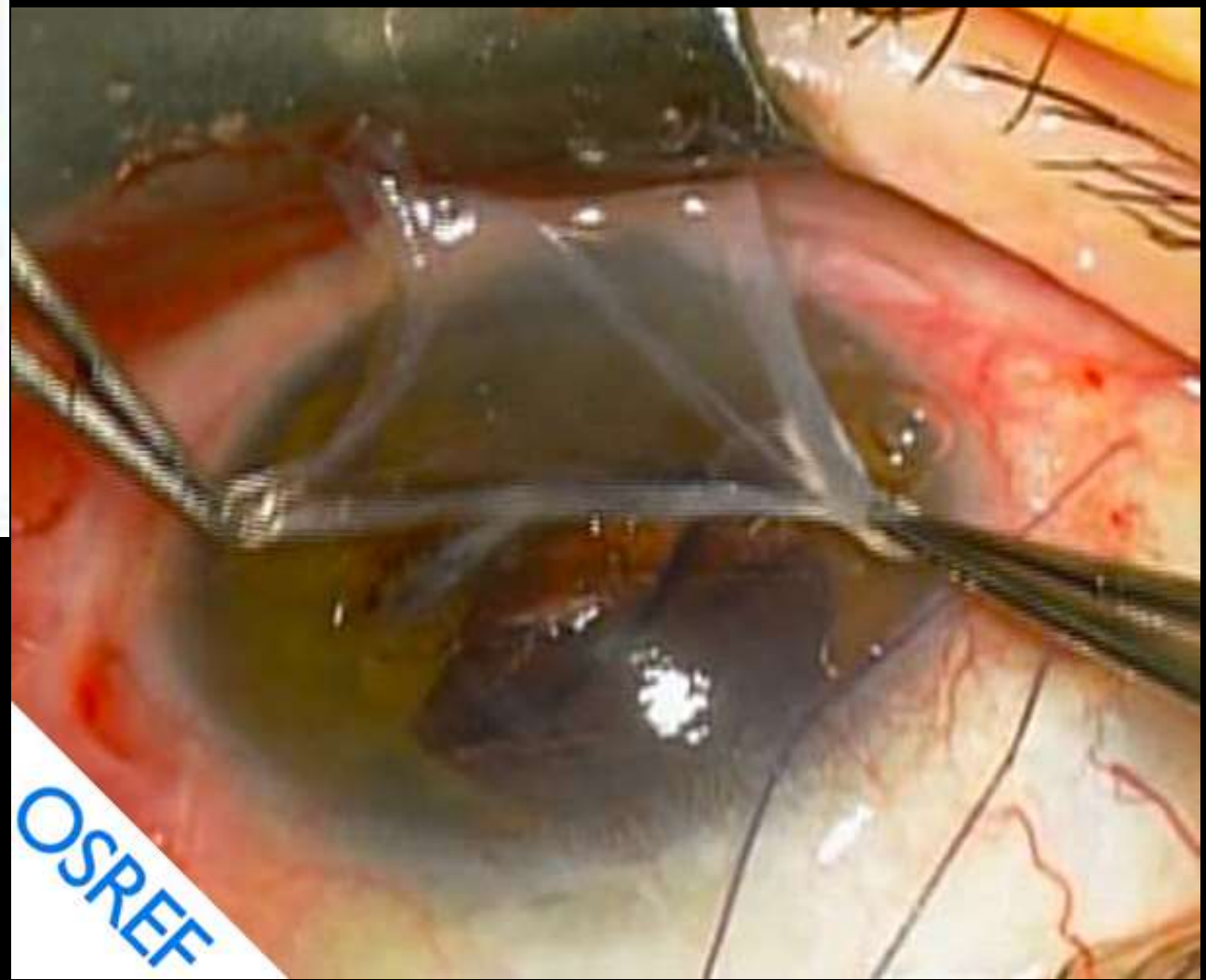
AMNIOTIC MEMBRANE TRANSPLANTATION (AMT)

- *It consists of a single cuboidal epithelium overlying a basement membrane. The basement membrane contains collagen (types 4 and 7), laminin (types 1 and 5), and fibronectin which provide a bed for extension of the native corneal epithelial cells over the membrane.*

- *Beneath the basement membrane, the so-called stroma, is cellular connective tissue that supports the epithelium and produces multiple growth factors that are essential for the proliferation and maintenance of corneal stem cells while inhibiting the production of fibrotic tissue by local fibroblasts.*

AMT

- *It has been demonstrated that amniotic membrane possesses anti- angiogenic, anti-inflammatory, anti-protease, and anti- microbial characteristics which are postulated to result from local modulation of signaling pathways.*



- *The AMT is very popular in current clinical practice and many authors recommend it immediately in the acute stage of grades III to VI Dua's classification.*

TENONPLASTY

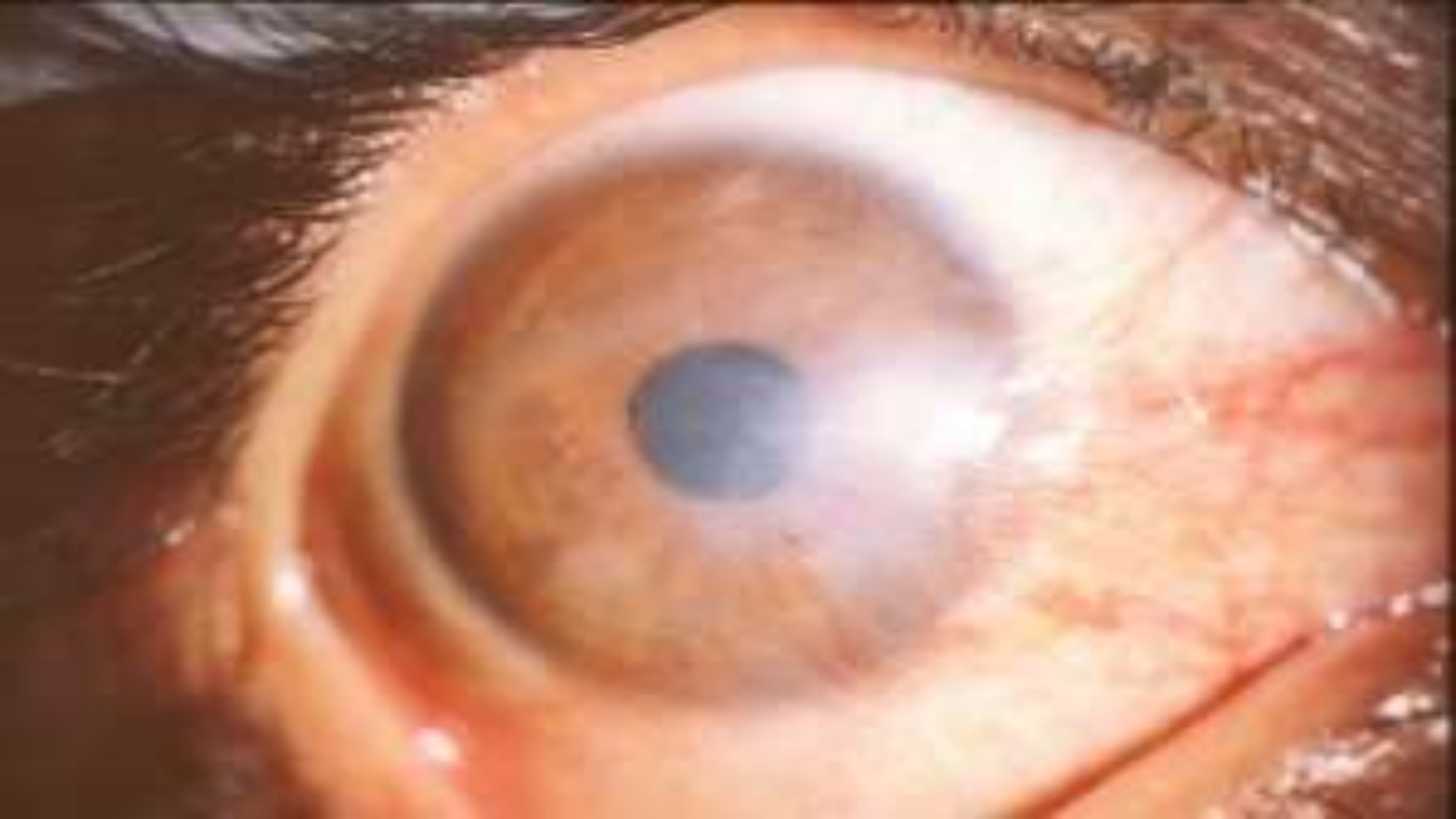
- *This procedure includes sufficient debridement of necrotic tissues, followed by the advancement of the remaining healthy Tenon's capsule adjacent to the limbus. This may be sutured alone or combined with AMT or may be augmented with tissue adhesives.*

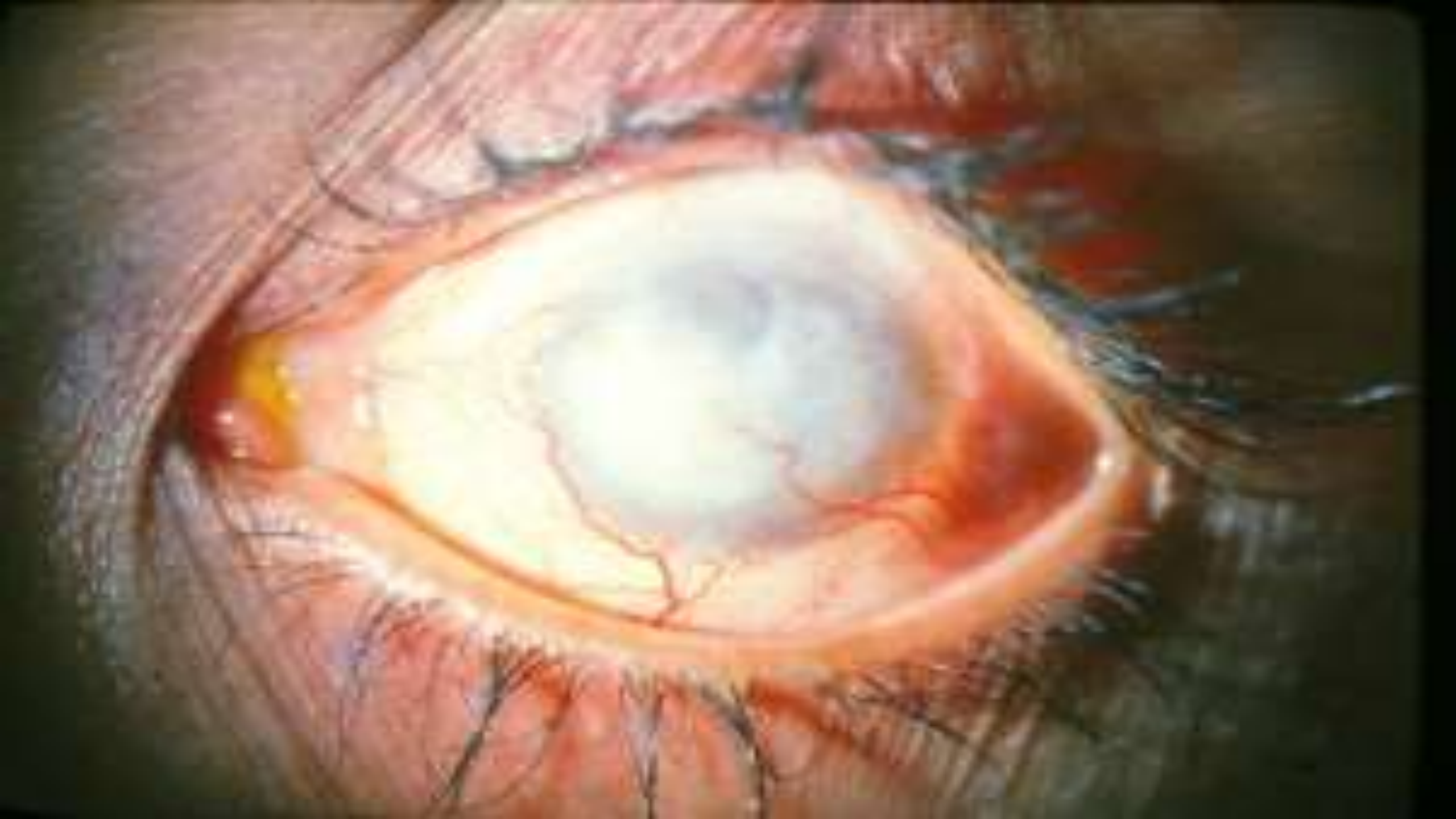
- *The goal is to provide the ischemic limbus with healthy vascular connective tissue thus preventing anterior segment necrosis and/or corneoscleral ulceration and melting while tissue repair and wound healing are promoted.*

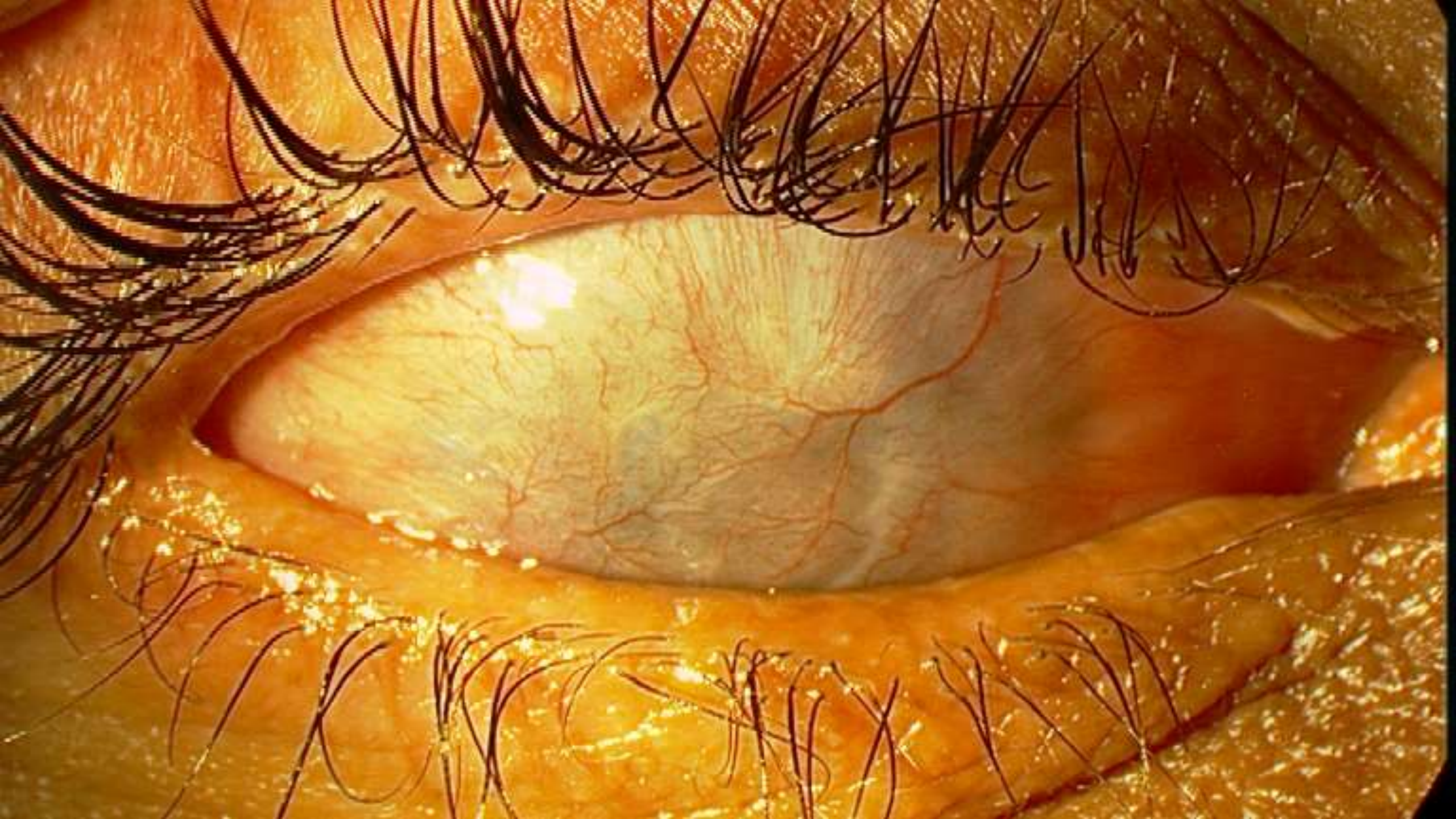
LIMBAL STEM-CELL TRANSPLANTATION (LSCT)

- *LSCT is an option when the corneal conjunctivalization is total or center-involving.*

- *Correction of structural abnormalities such as symblepharon or cicatricial entropion and/or ectropion take priority over LSCT.*



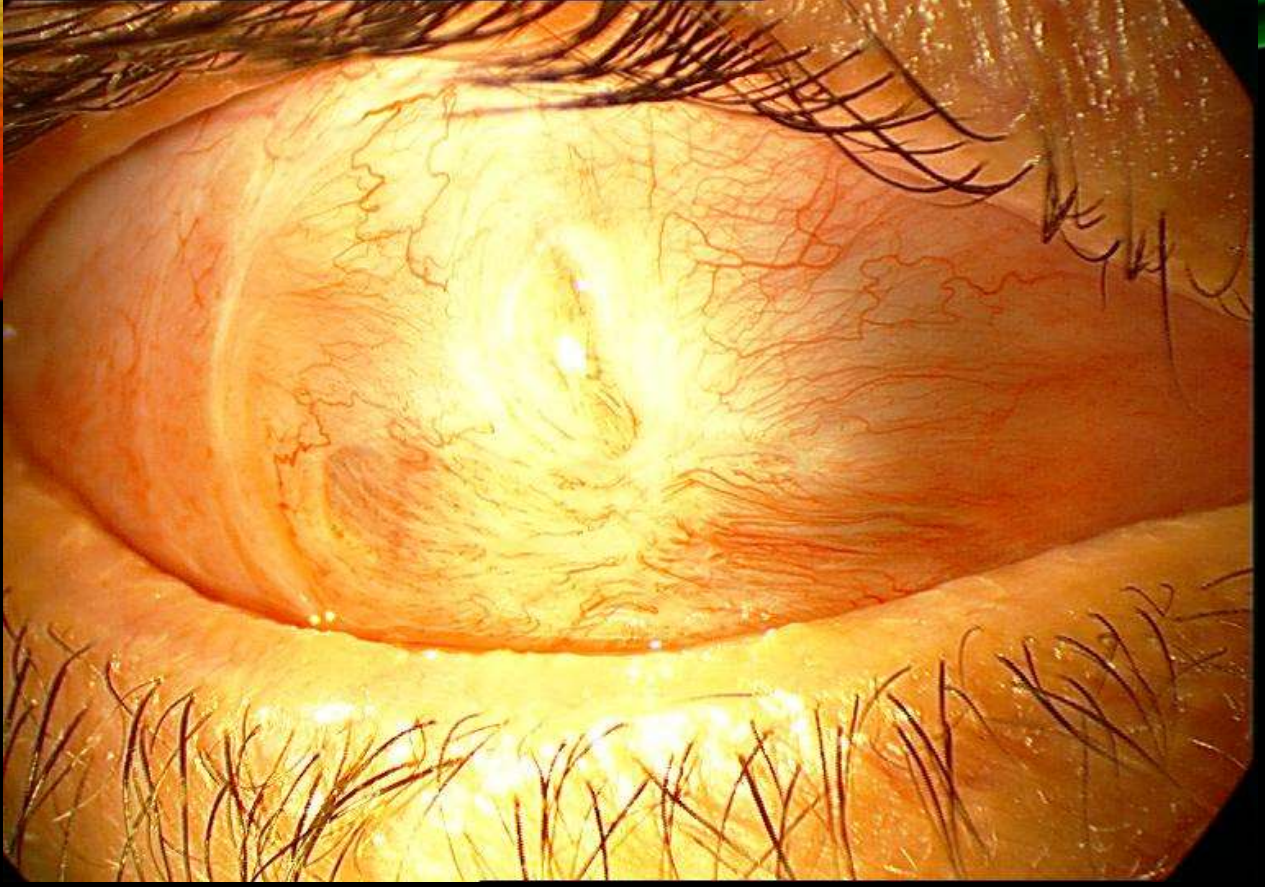




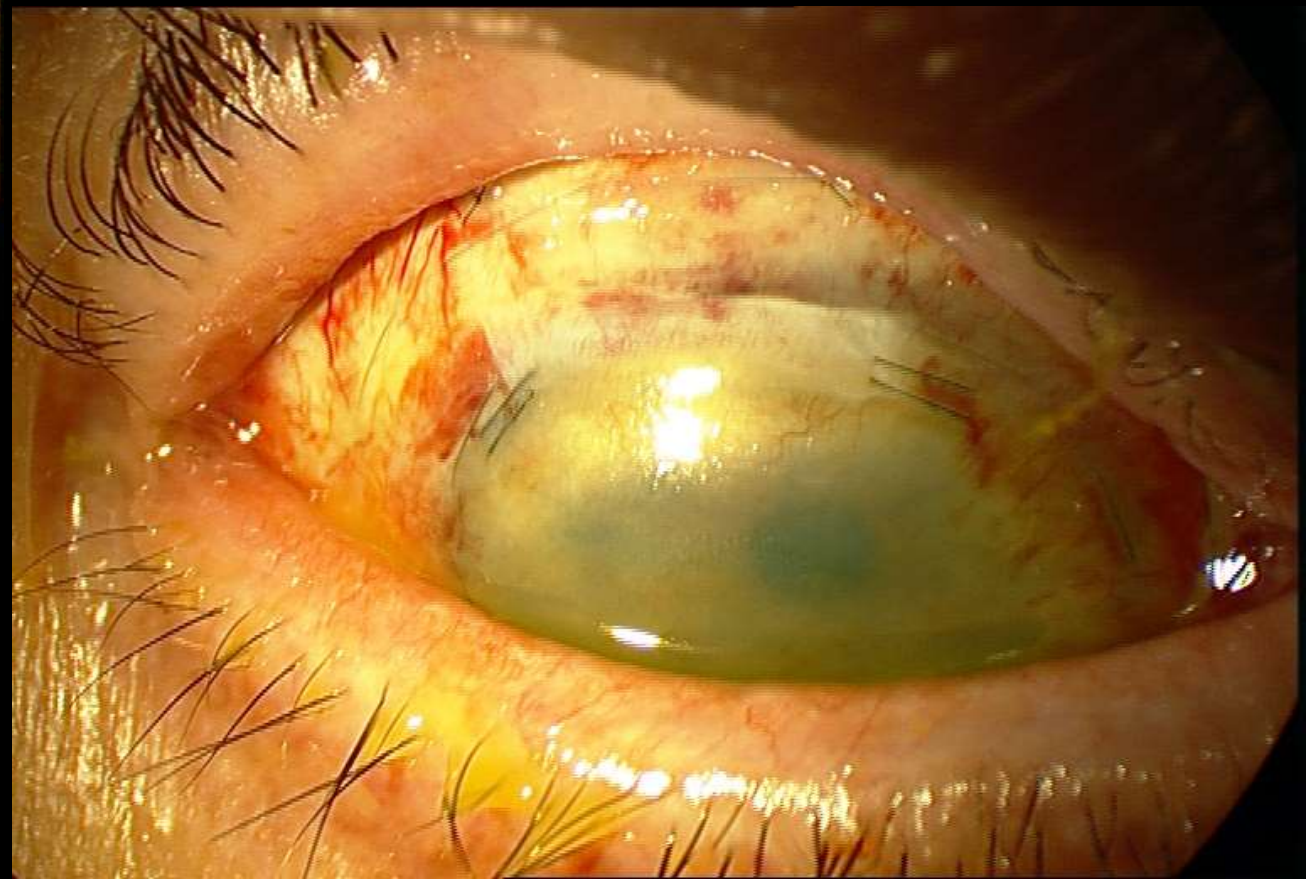
- *In unilateral cases, the healthy eye is used to acquire conjunctival limbal autograft (CLAU) which brings about excellent outcomes in terms of re-epithelialization and visual acuity.*

- *If bilateral but asymmetric involvement is the case, cultivated limbal epithelial transplantation (CLET) is an option.*

- *When bilateral LSCD is severe and symmetric, limbal stem-cells can be harvested from allograft donors either as living-related conjunctival limbal allograft (lr-CLAL) or keratolimbal allograft (KLAL)*



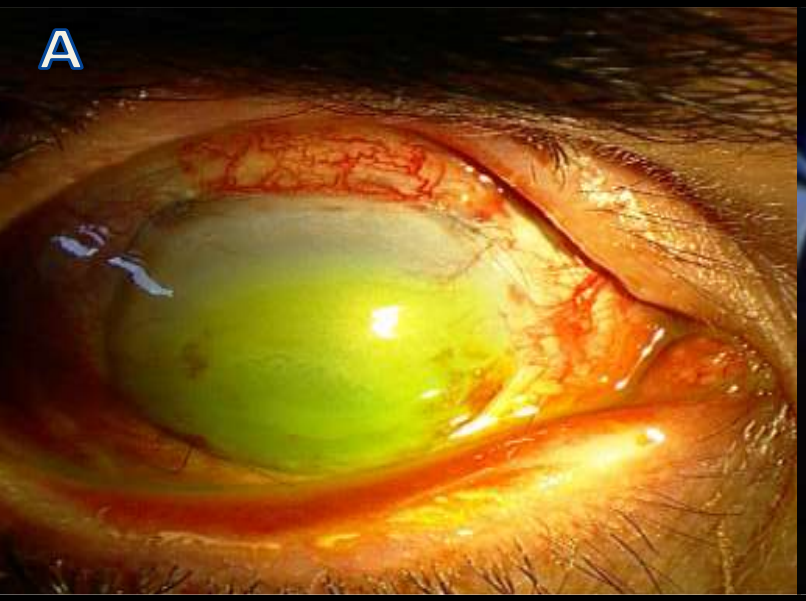
CLAU

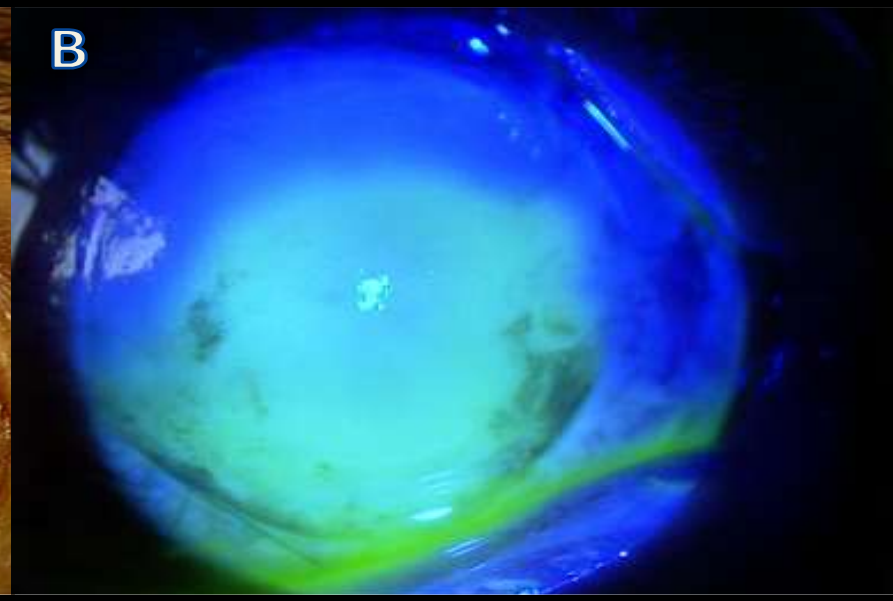


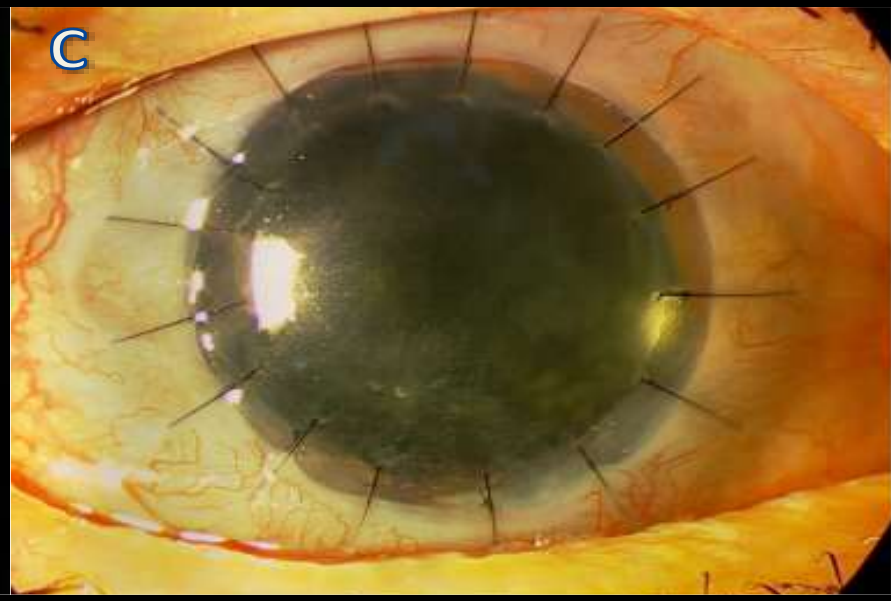
KERATOPLASTY

- *Corneal transplantation is considered for those with visually significant stromal scars and perforations.*
- *Both penetrating keratoplasty (PK) and deep anterior lamellar keratoplasty (DALK) are acceptable but the latter is a better option due to the lesser chance of rejection.*
- *It is advised to delay keratoplasty for at least three months after LSCT.*

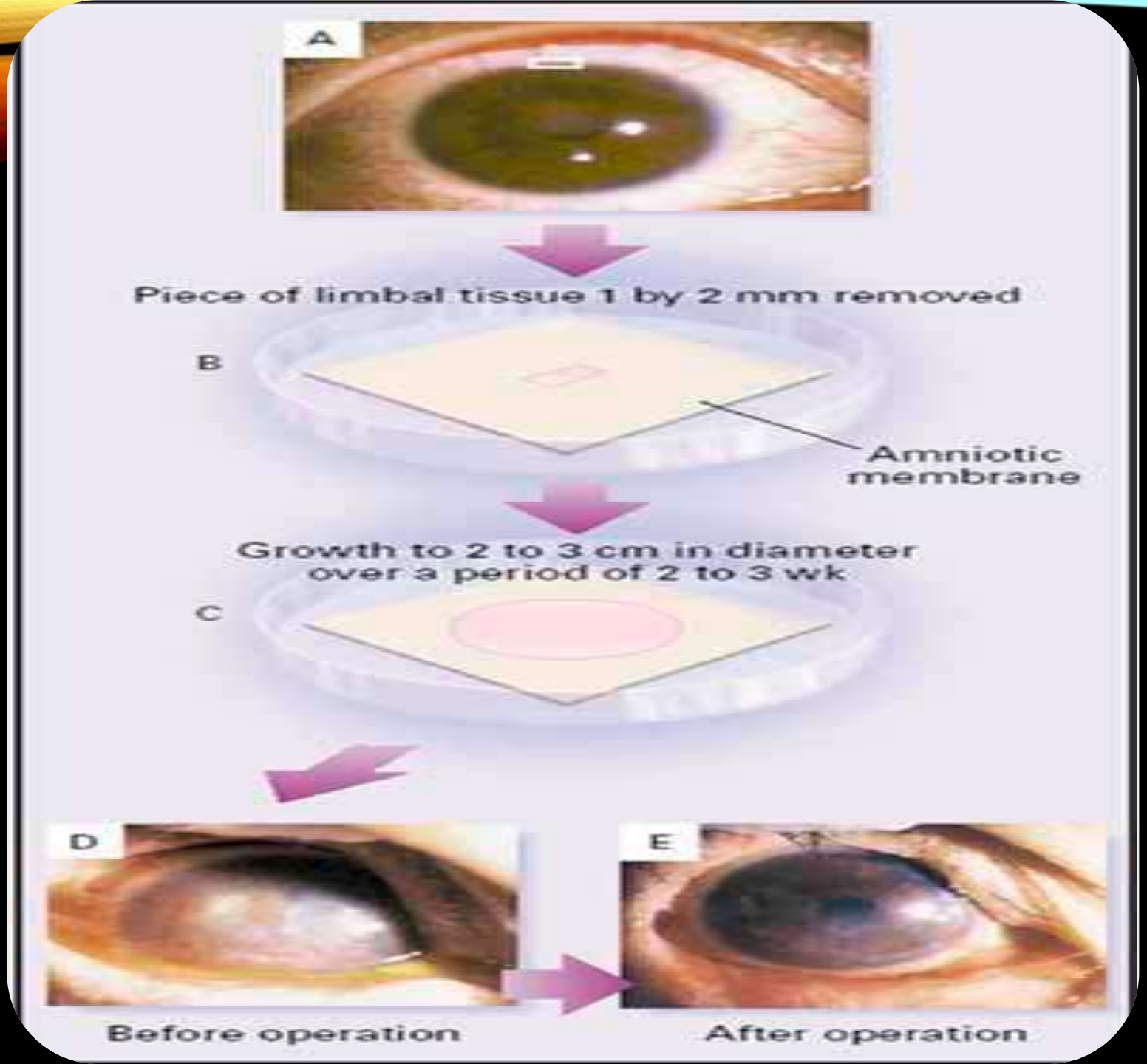
CLAU+PK



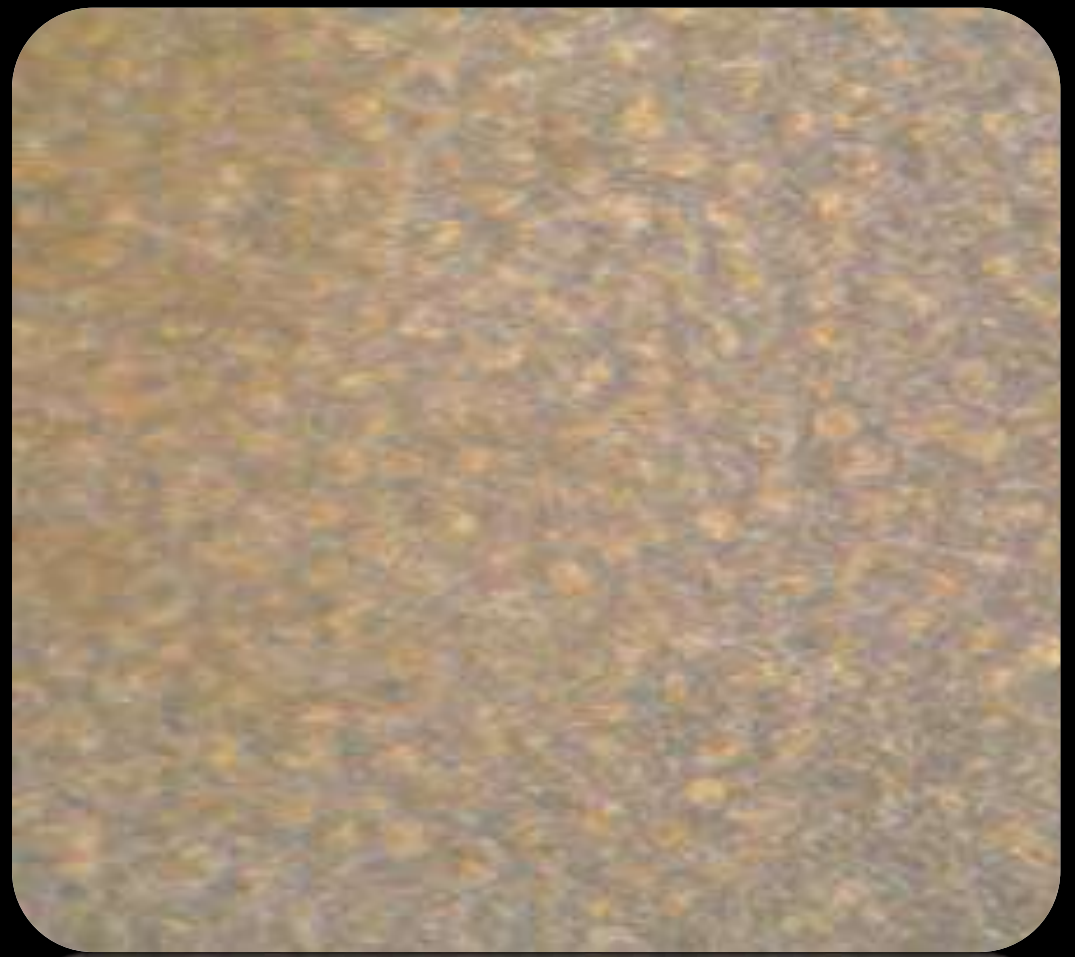


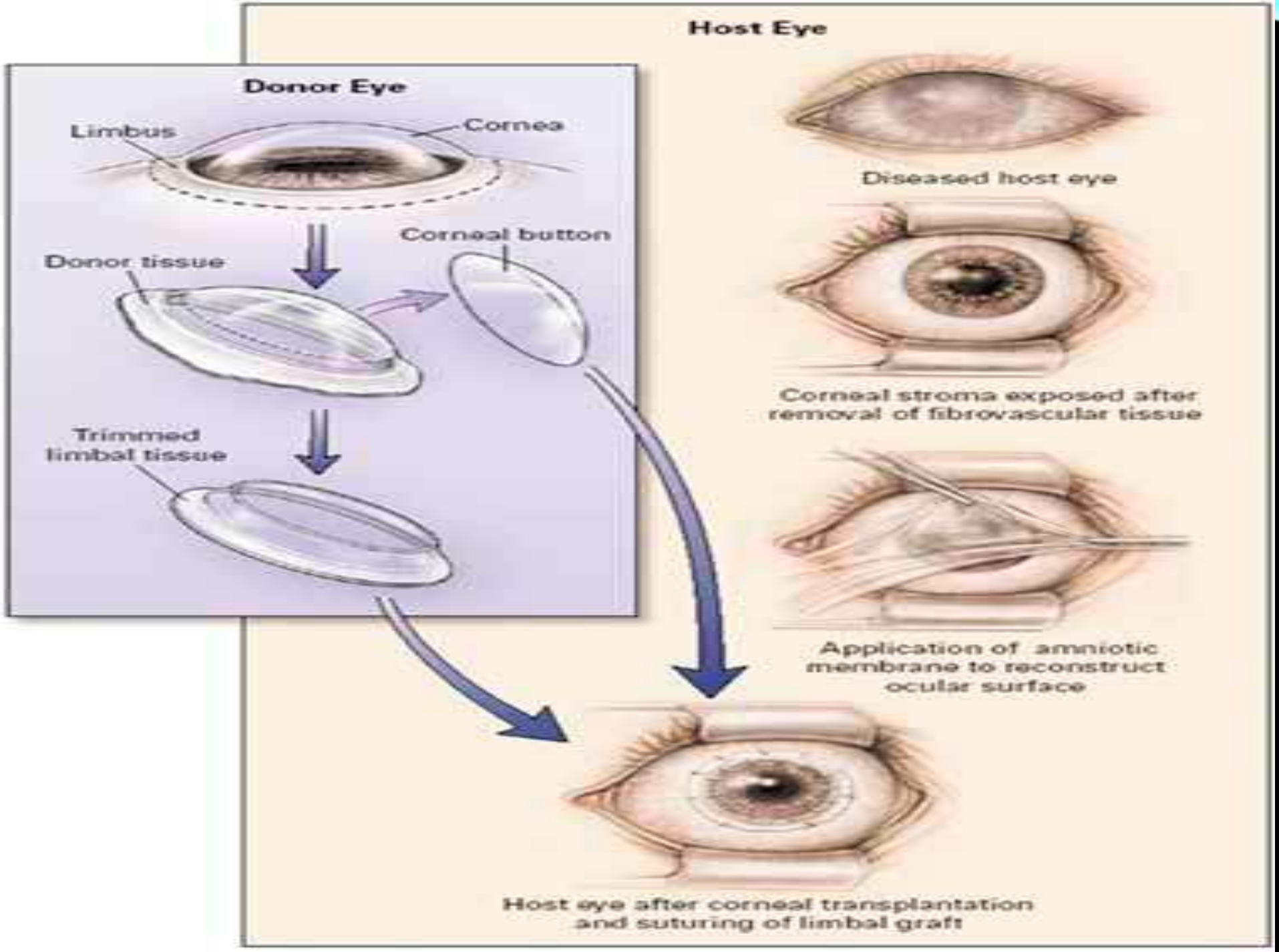


CLET

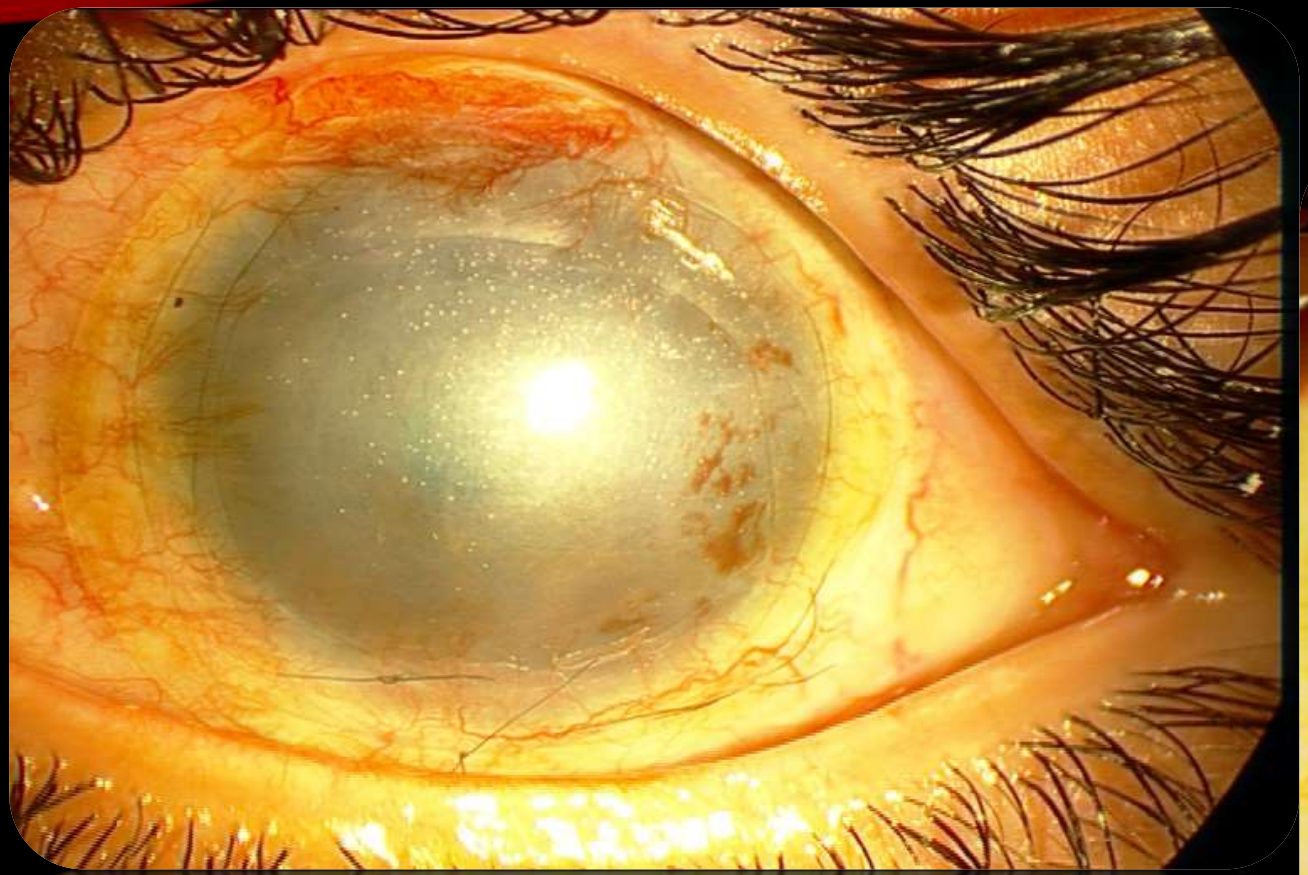

A
Piece of limbal tissue 1 by 2 mm removed
B
Amniotic membrane
Growth to 2 to 3 cm in diameter over a period of 2 to 3 wk
C
D
E
Before operation
After operation

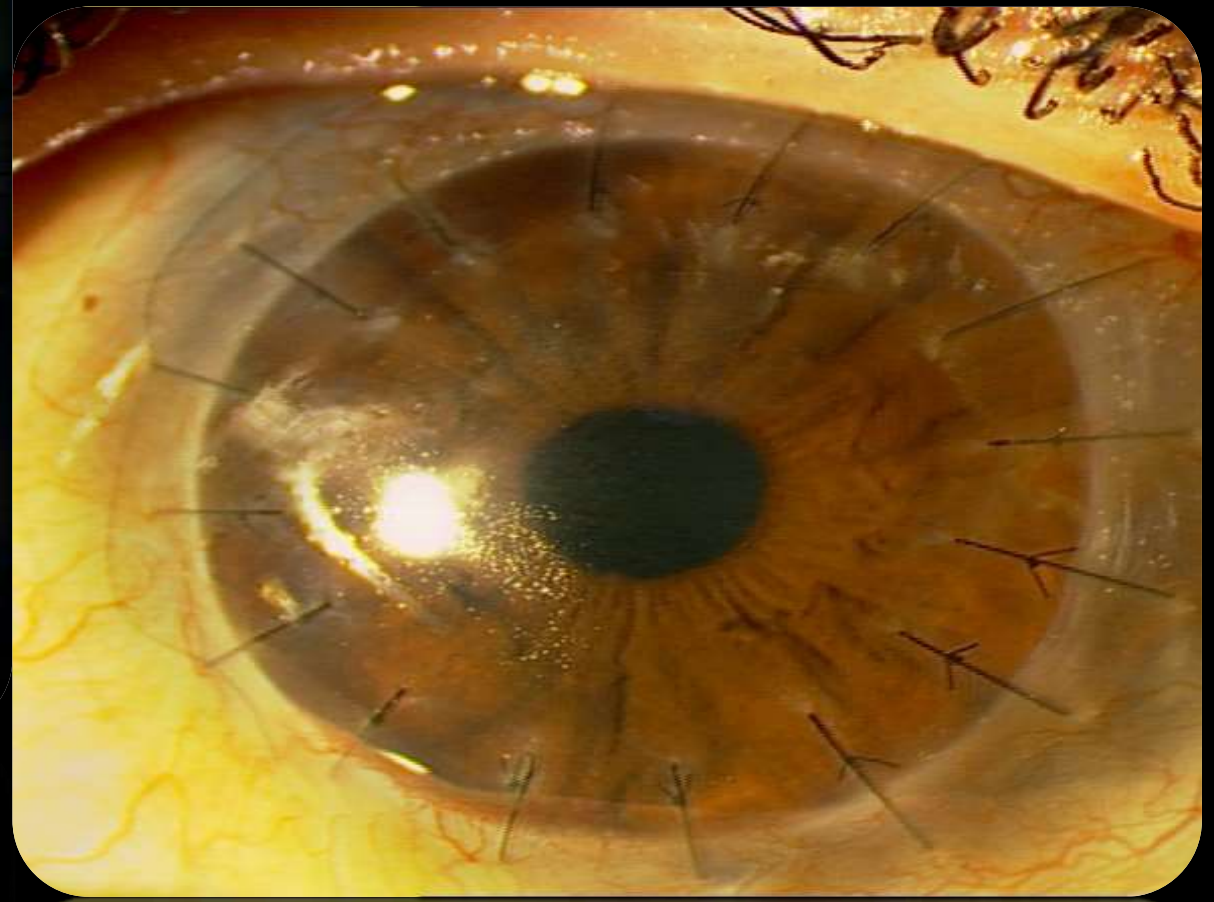
A Culture plate with the tightened amniotic membrane and a limbal biopsy placed in the center (arrows).
Phase-contrast microscopy of the expanded cells reveals a monolayer of epithelial cells of small and uniform size.




Donor Eye
Limbus
Cornea
Corneal button
Donor tissue
Trimmed
limbal tissue
Host Eye
Diseased host eye
Corneal stroma exposed after
removal of fibrovascular tissue
Application of amniotic
membrane to reconstruct
ocular surface
Host eye after corneal transplantation
and suturing of limbal graft

COMET





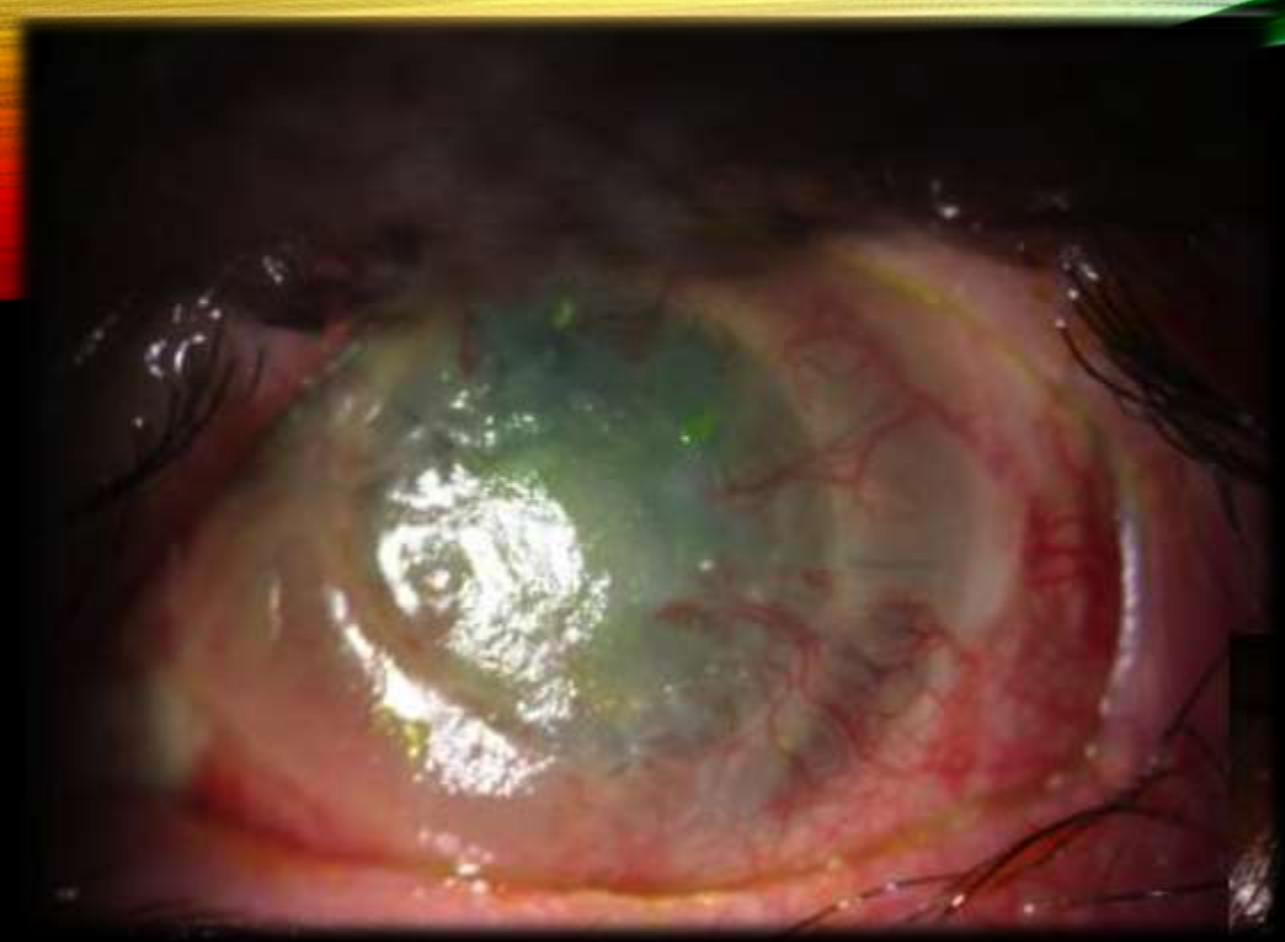
KERATOPROSTHESIS

- *Keratoprosthesis is indicated when multiple keratoplasty procedures have failed and the chance of a new successful keratoplasty is extremely low.*

- *In patients with minimal tear production, Boston type 1 keratoprosthesis (B1-KPro) may be tolerated especially in combination with LSCT and other reconstructive procedures.*

- *Finally, in extremely dry eyes or severe surface keratinization, or select cases with non-functional lids, Boston type 2 (B2- KPro), or osteo-odonto-keratoprosthesis (OOKP) may be recommended as a salvage treatment.*

KPRO



Thank You