17th Annual International Meeting of Research Institute of Ophthalmology (RIO)
Jan 30 - 31, 2025, Royal Maxim Palace Kempinski Cairo, Egypt.

Course 1: Keratoplasty surgical pearls

Deep Anterior Lamellar Keratoplasty (DALK): Science for Successful Surgery

Professor Harminder Sigh Dua, CBE, CMLJ, DL

MBBS(Nagpur), DO(Nagpur), DO(London), MS(Nagpur), MNAMS(NAMS, India), FRCS(Edinburgh), FRCOphth.(UK), FEBO(EU), FCOptom.(UK, Hon.), FRCP(Edinburgh, Hon.), FRCOphth.(UK, Hon.), FAICO(India, Hon.), MD(Aberdeen), PhD(Nagpur)

Chair and Professor of Ophthalmology

RIO

The University of Nottingham

Deep Anterior Lamellar Keratoplasty (DALK)

Big Bubble technique

- Air injection
- Visco-dissection

Manual Dissection

All attempt to reach the deepest plane anterior to Descemet's membrane (DM) or pre-Descemet's Layer (PDL)

Lamellar Keratoplasty

Deep Anterior Lamellar Keratoplasty

a. Air injection

Dua HS and Said DG. Deep Anterior Lamellar Keratoplasty (DALK): Science and Surgery. © Springer Nature Switzerland AG 2021. D. M. Albert et al. (eds.), Albert and Jakobiec's Principles and Practice of Ophthalmology, https://doi.org/10.1007/978-3-319-90495-5_218-1

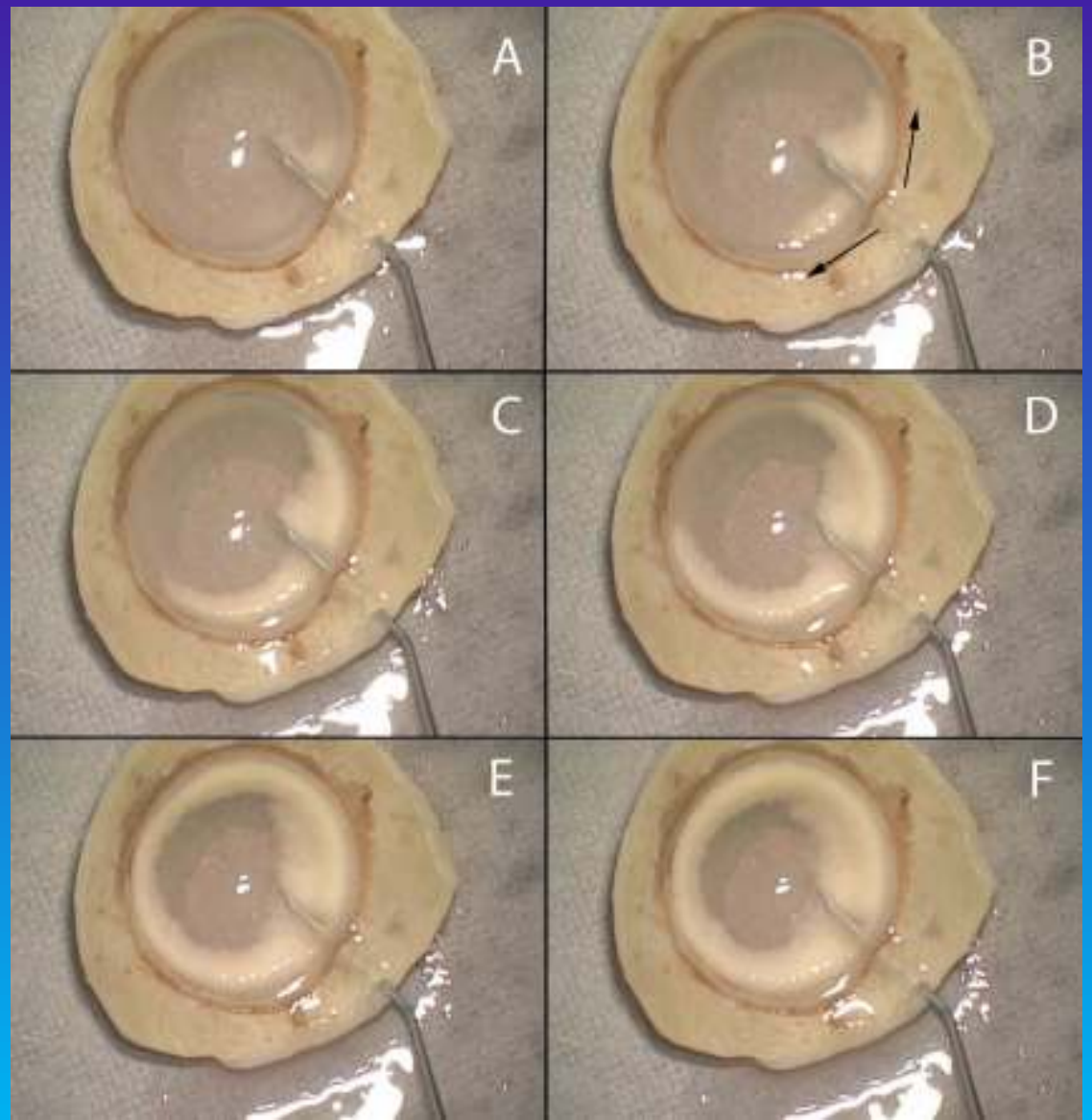
Dua HS, Freitas R, Mohammed I, Ting DSJ, Said DG. The pre-Descemet's layer (Dua's layer, also known as the Dua-Fine layer and the pre-posterior limiting lamina layer): Discovery, characterisation, clinical and surgical applications, and the controversy. Prog Retin Eye Res. 2023 Jan 13:101161. doi: 10.1016/j.preteyeres.2022.101161.

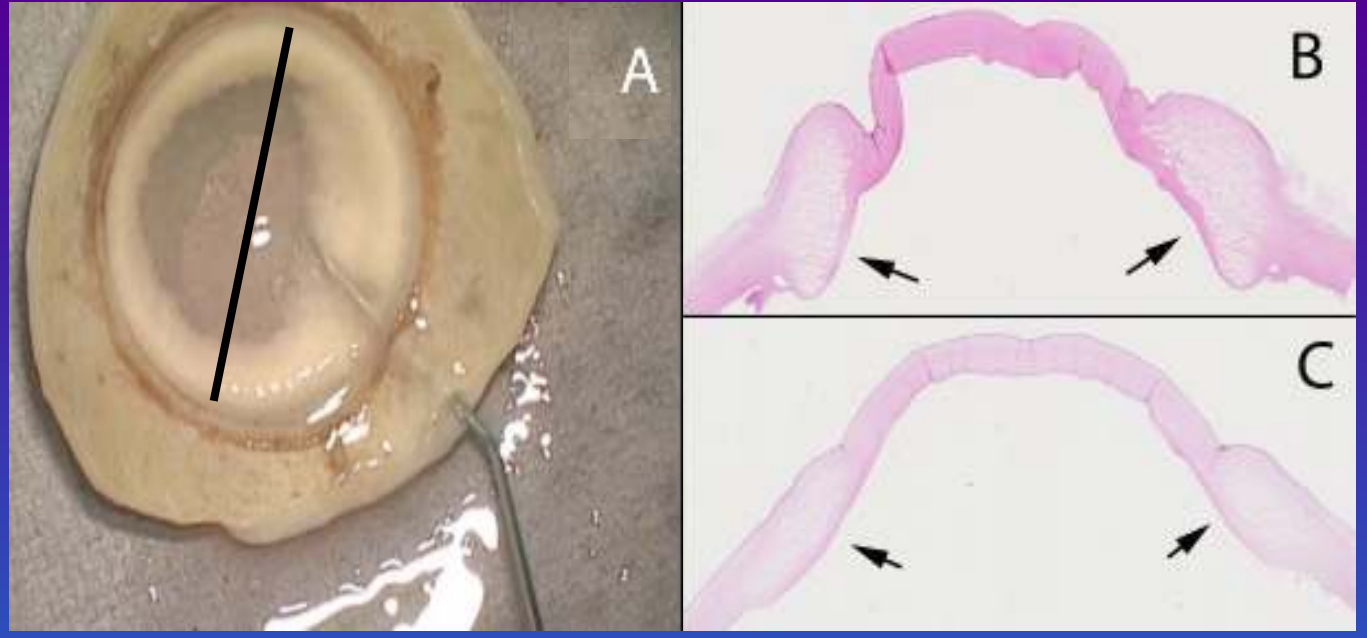
Early passage of air in corneal stroma:

1. Radial tracks to limbus
2. ‘Cracks in glass’ appearance
3. Diffuse
4. Combination(s) of above

Dua HS, et al. Dynamics of big bubble formation. Acta Ophthalmol. 2018 Feb;96(1):69-76.

Circumferential movement of air along corneal periphery



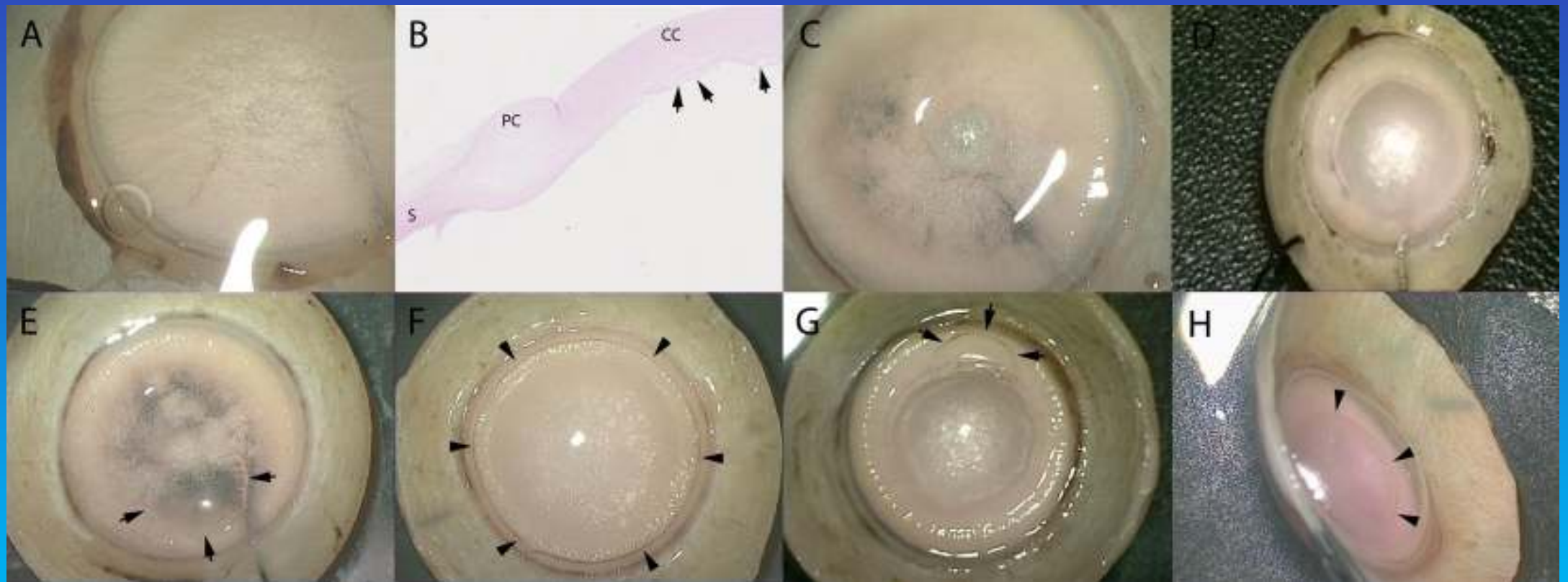


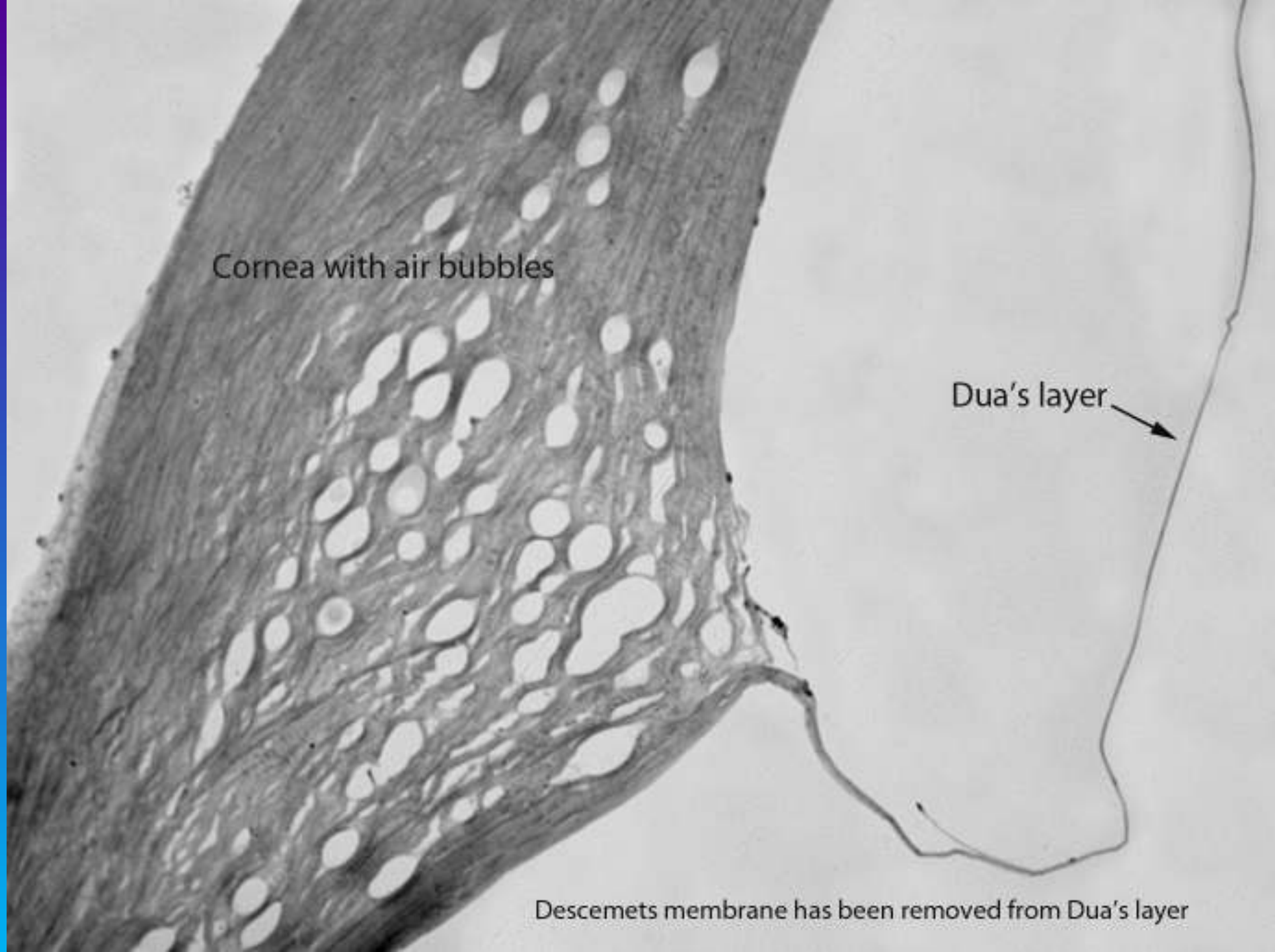
Peripheral circular band of air spares the most anterior and most posterior stroma

Late passage of air:

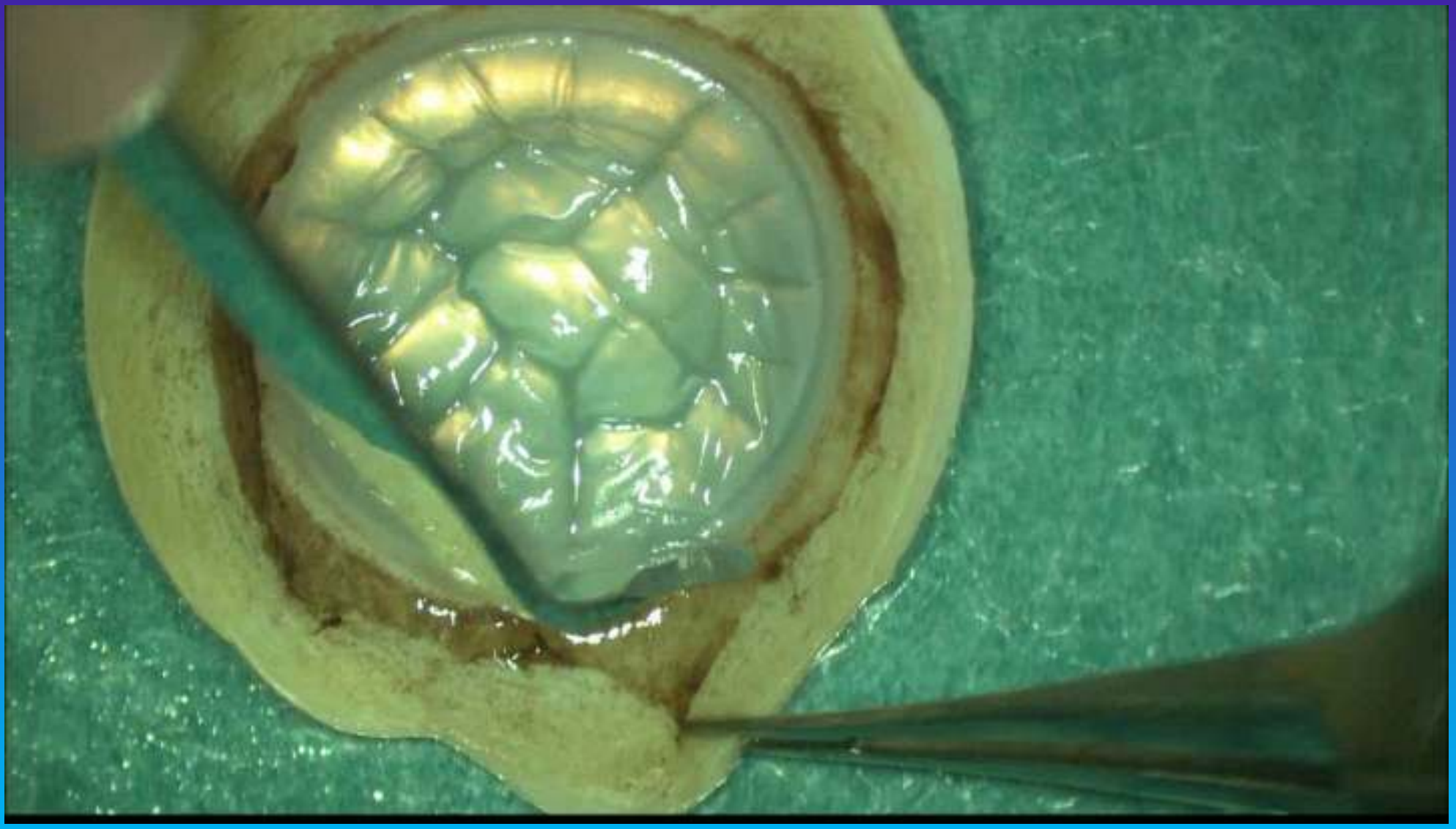
Sequence of formation of type 1 and type 2 bubbles

Dua HS, et al. Dynamics of big bubble formation. Acta Ophthalmol. 2018 Feb;96(1):69-76.




Cornea with air bubbles
Dua's layer
Descemets membrane has been removed from Dua's layer

Ablation of pre-Descemet's layer eliminates possibility of obtaining Type 1 big bubble



Dua HS, et al. Acta Ophthalmol. 2015; 93(5):427-30

DALK Big-bubble: The cleavage plane

Type 1: Wall us made of EC, DM and Pre-Descemet's layer

- > 80% occasions DM is not bared.
- Cleavage occurs in a tissue plane ~ 20 μ anterior to DM
- Bubble ≤ 8 to 9mm

Type-1 Big Bubble

Dua HS, Faraj LA, Said DG, Gray T, Lowe J. Human Corneal Anatomy Redefined: A Novel Pre-Descemet's Layer (Dua's Layer). Ophthalmology. 2013;120(9):1778-85.

DALK Type 1 Big-bubble in vivo

Starts in centre

White ring

Usually extends up to 8-9mm

There is a cleavage plane between PDL and Stroma.

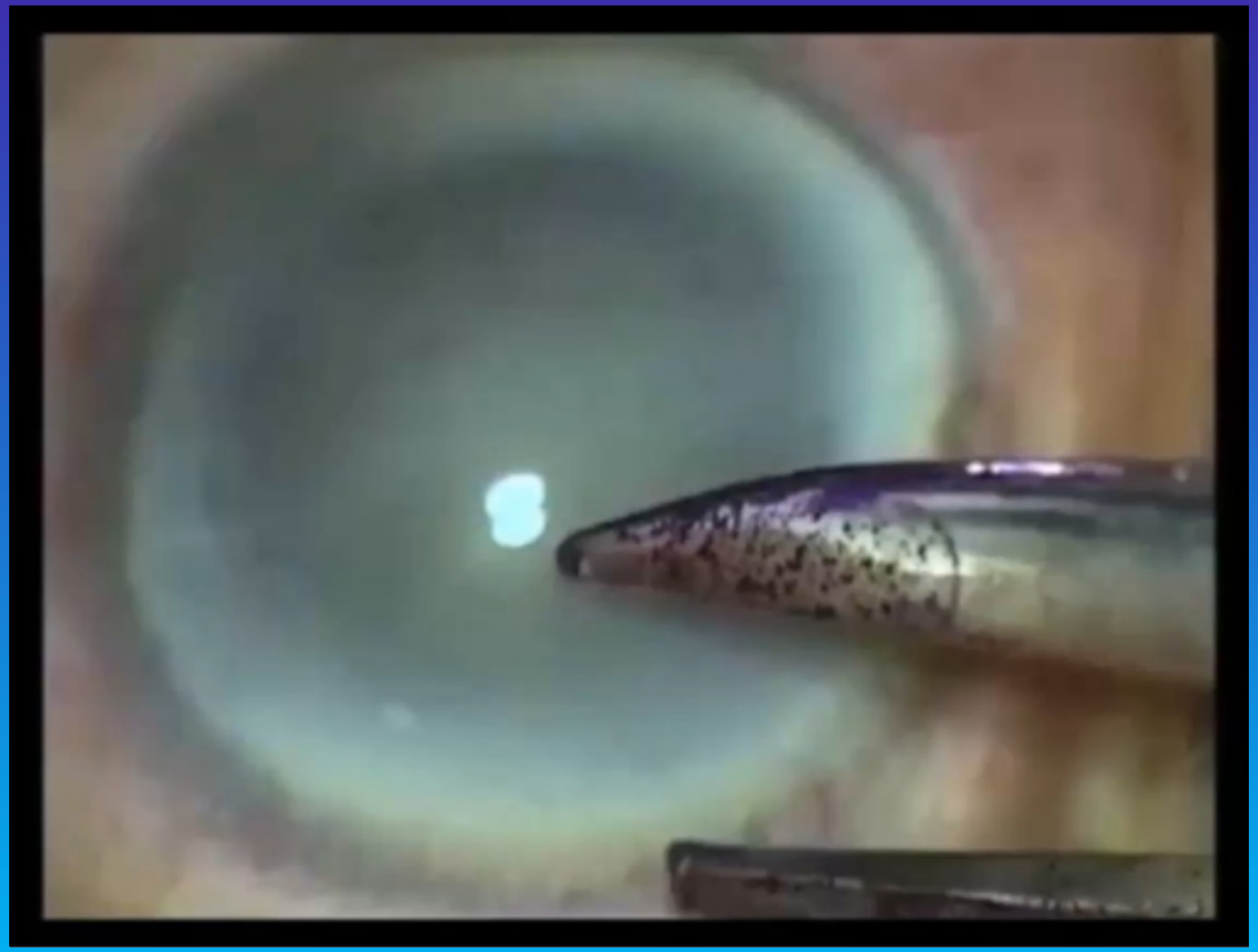
PDL is much stronger than DM

Type 1 BB bursts around 700mm Hg pressure

Too much air injected quickly can raise the intra bubble pressure very high

DALK – Triple only possible with Type-1 BB

Phacoemulsification thorough DL during DALK.



Zaki AA, Elalfy MS, Said DG, Dua HS. Deep anterior lamellar keratoplasty-triple procedure: a useful clinical application of the pre-Descemet's layer (Dua's layer). Eye (Lond). 2015; 29(3):323-6

DALK Big-bubble: The cleavage plane

Type 2: Wall is made of EC and DM

- Glassy bubbles/explosive bubbles are variations of the same.
- < 20% occasions Descemet's is bared.

Type-2 Big Bubble

DALK Type 2 Big Bubble in vivo

Usually starts at the periphery

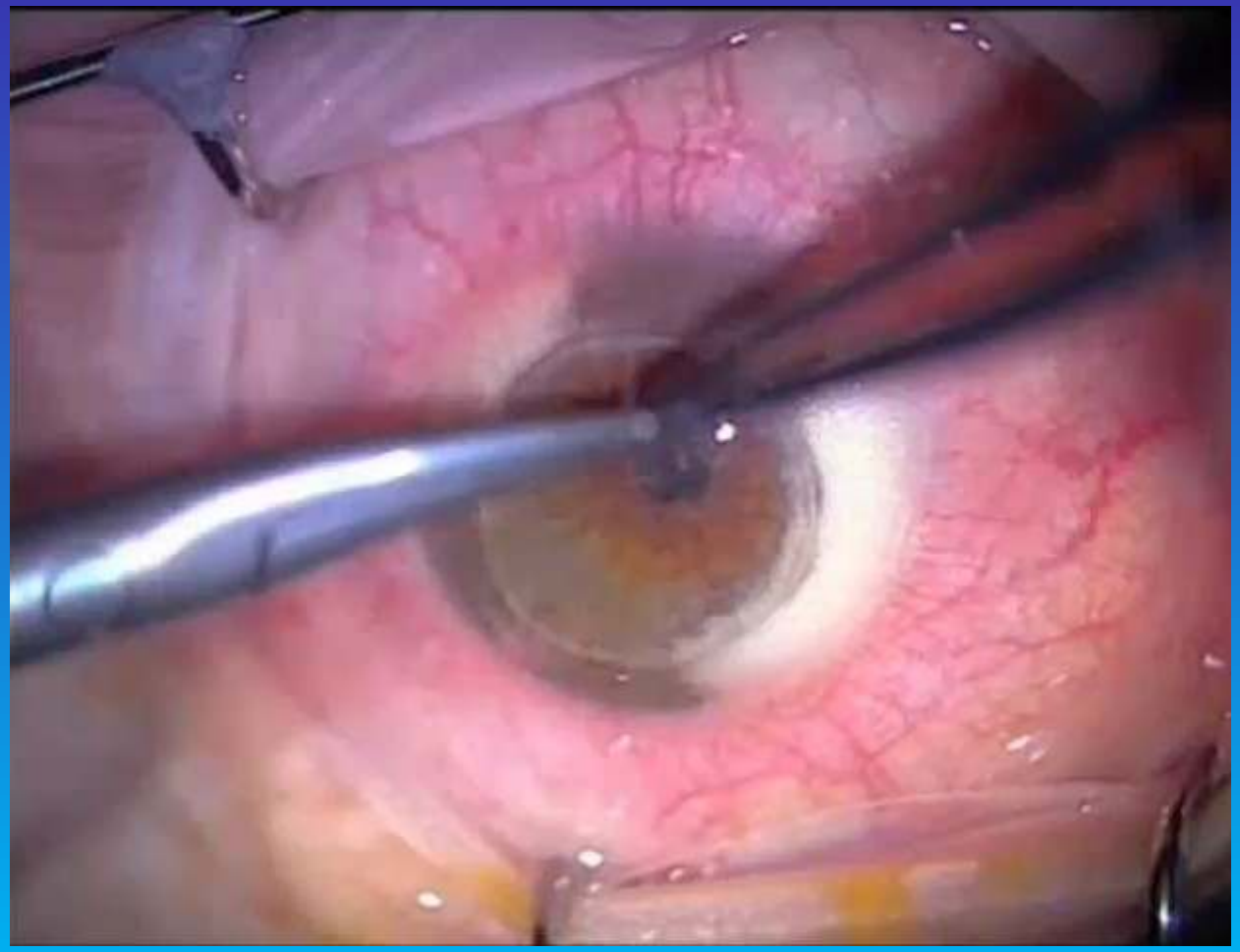
Extends beyond the edge of the trephine cut, often to the periphery

No white ring

Arrows – margin of bubble, well beyond trephine mark.

DM is very fragile

Type 2 BB bursts readily



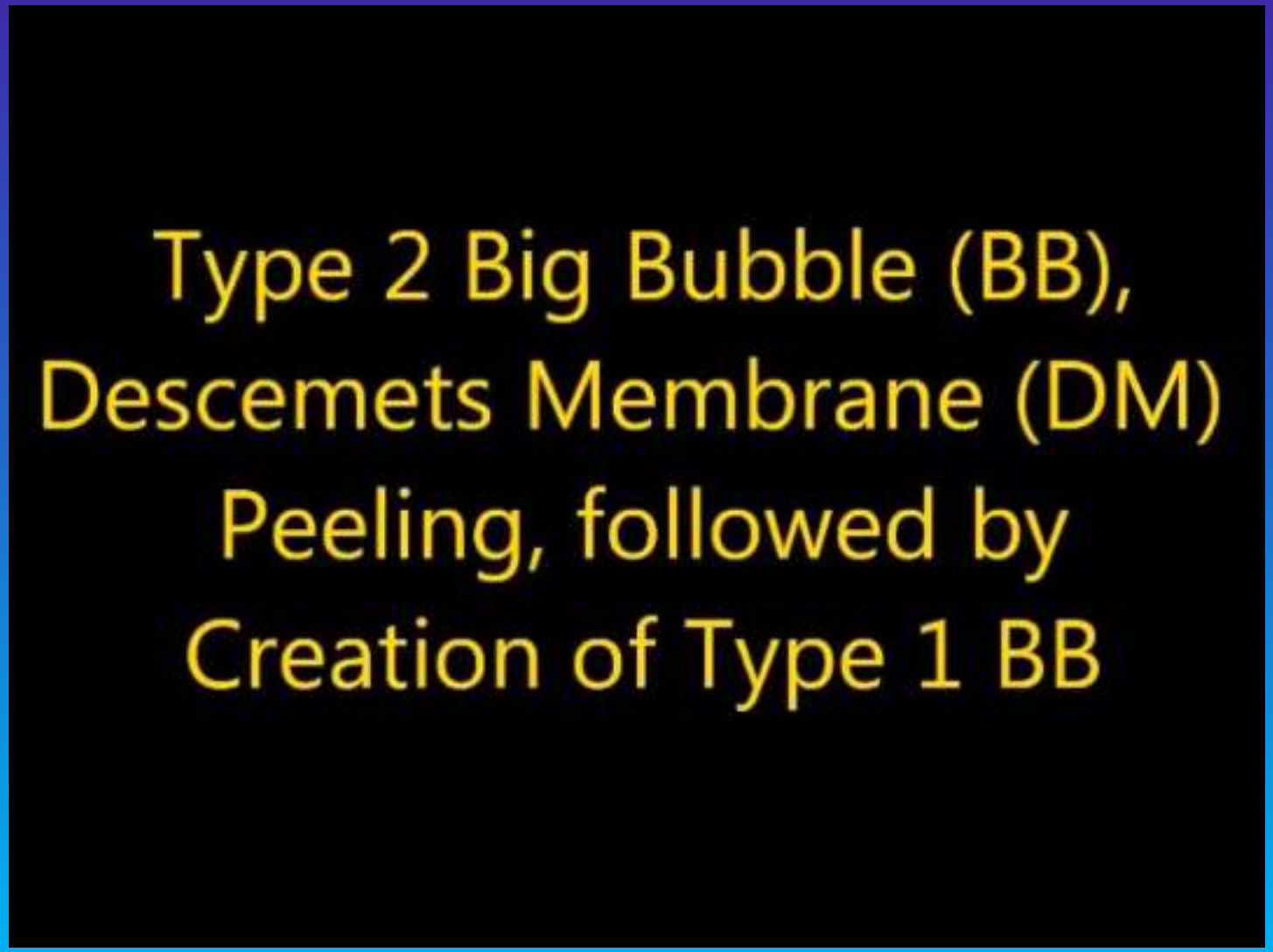
A tense DM is like a tense balloon

Ruptures (burst) easily

Keep IOP low and DM flaccid by repeated paracentesis

DM is not essential for the creation of the ‘type 1’ big bubble

Peeling Descemet’s membrane off a Type 2 BB causes it to deflate.
Type 1 BB can be created after peeling DM.

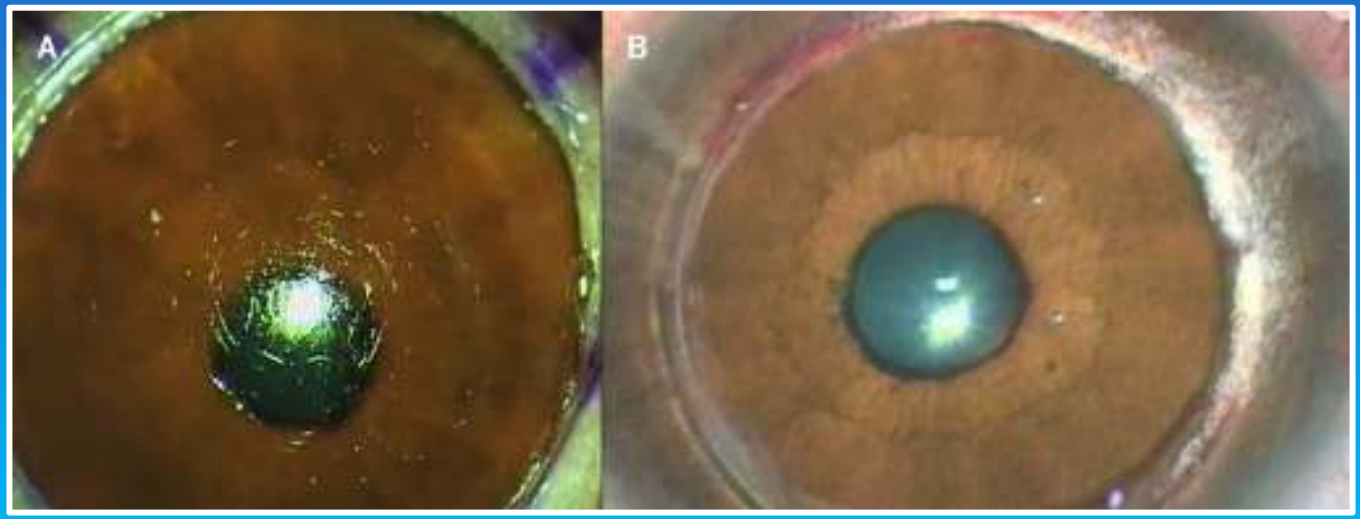


PDL and Posterior stroma attachments

Strands of collagen are more evident at the periphery of a TI BB

Not seen between DM and PDL

Broken strands give a rough appearance to anterior surface of T1 BB



DALK Big-bubble: The cleavage plane

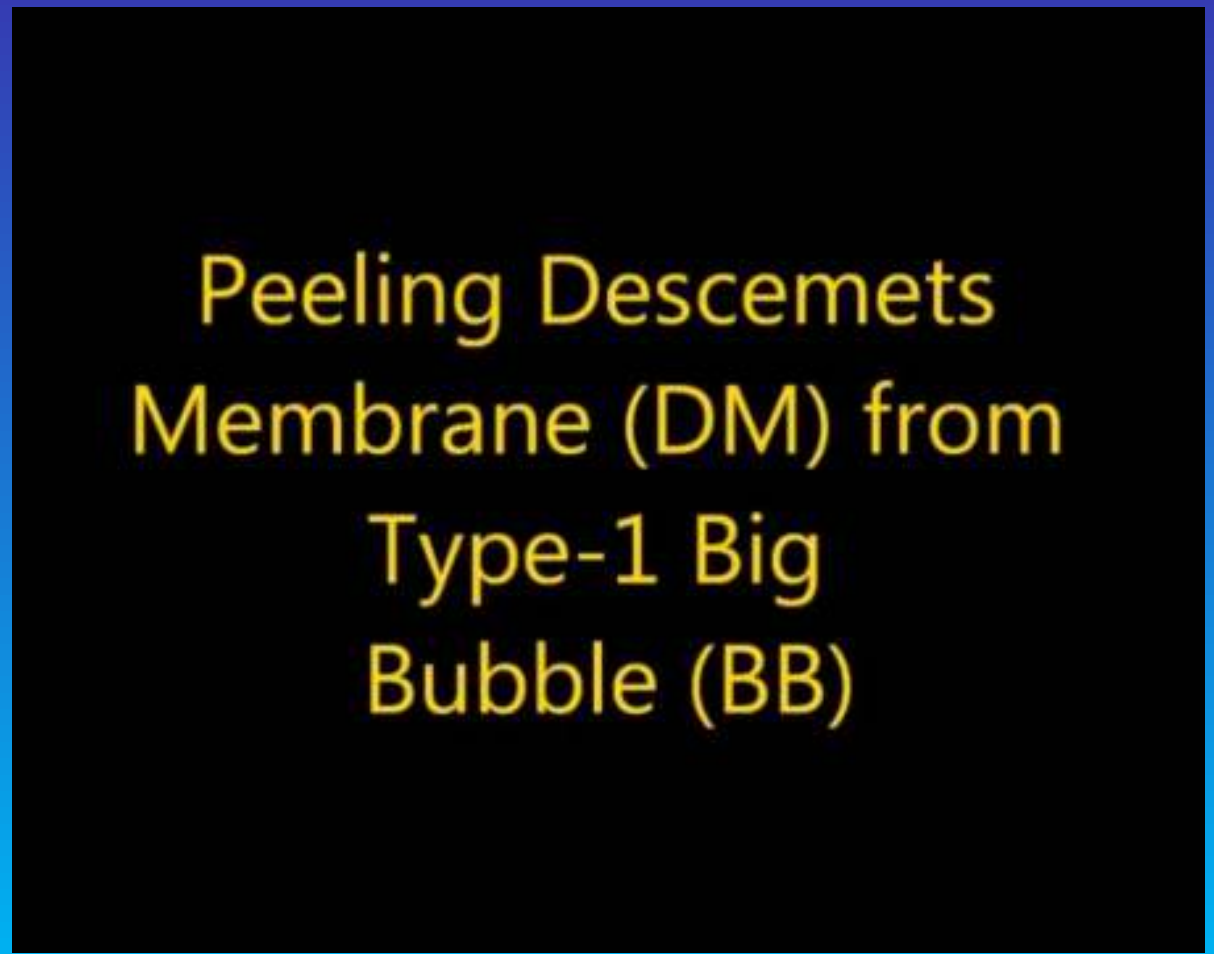
Mixed bubbles: combination of Type 1 and Type 2 BB

Mixed bubbles:

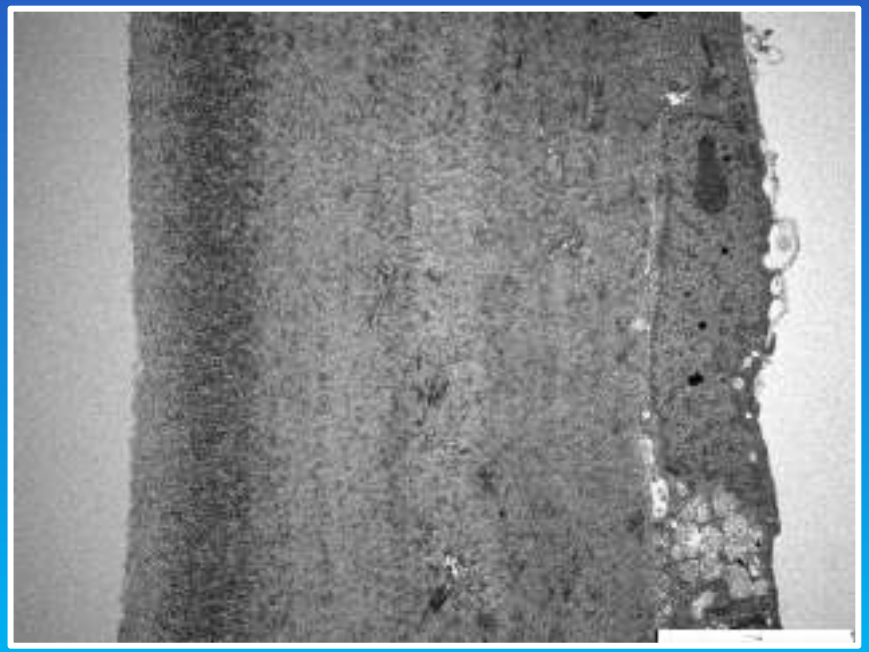
- Can be partial T2, or Total
- DM is <u>not</u> split between banded and non-banded zones

DALK Big-bubble: The cleavage plane

DM can be peeled off PDL in Type 1 and Mixed Big Bubbles.

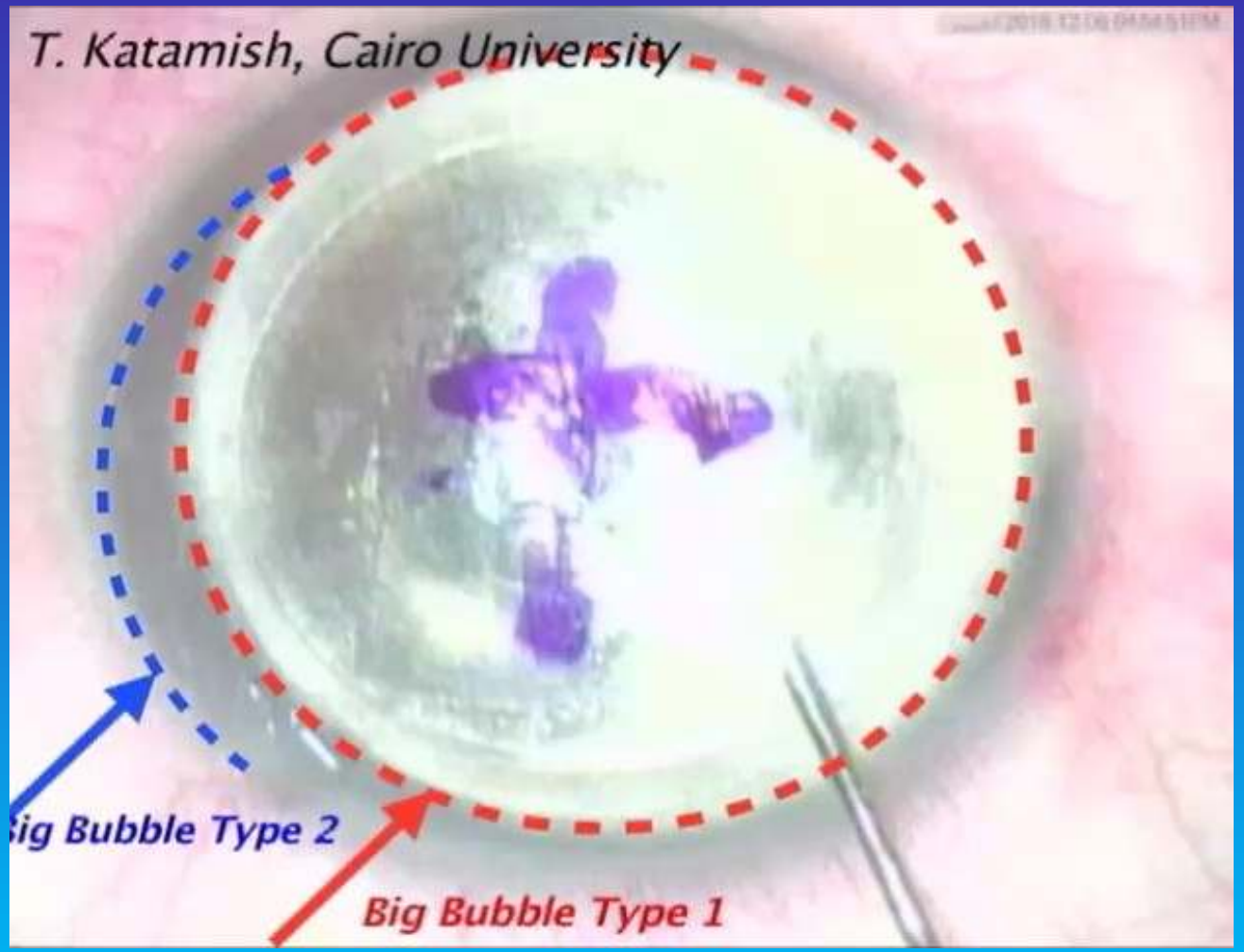


- The BB does not collapse
- The PDL is impervious to air
- DM removed from Mixed BB) or Type 1 or Type 2 BB is not split



DALK Mixed Big Bubble in vivo

Mixed bubbles: combination of Type 1 and Type 2 BB



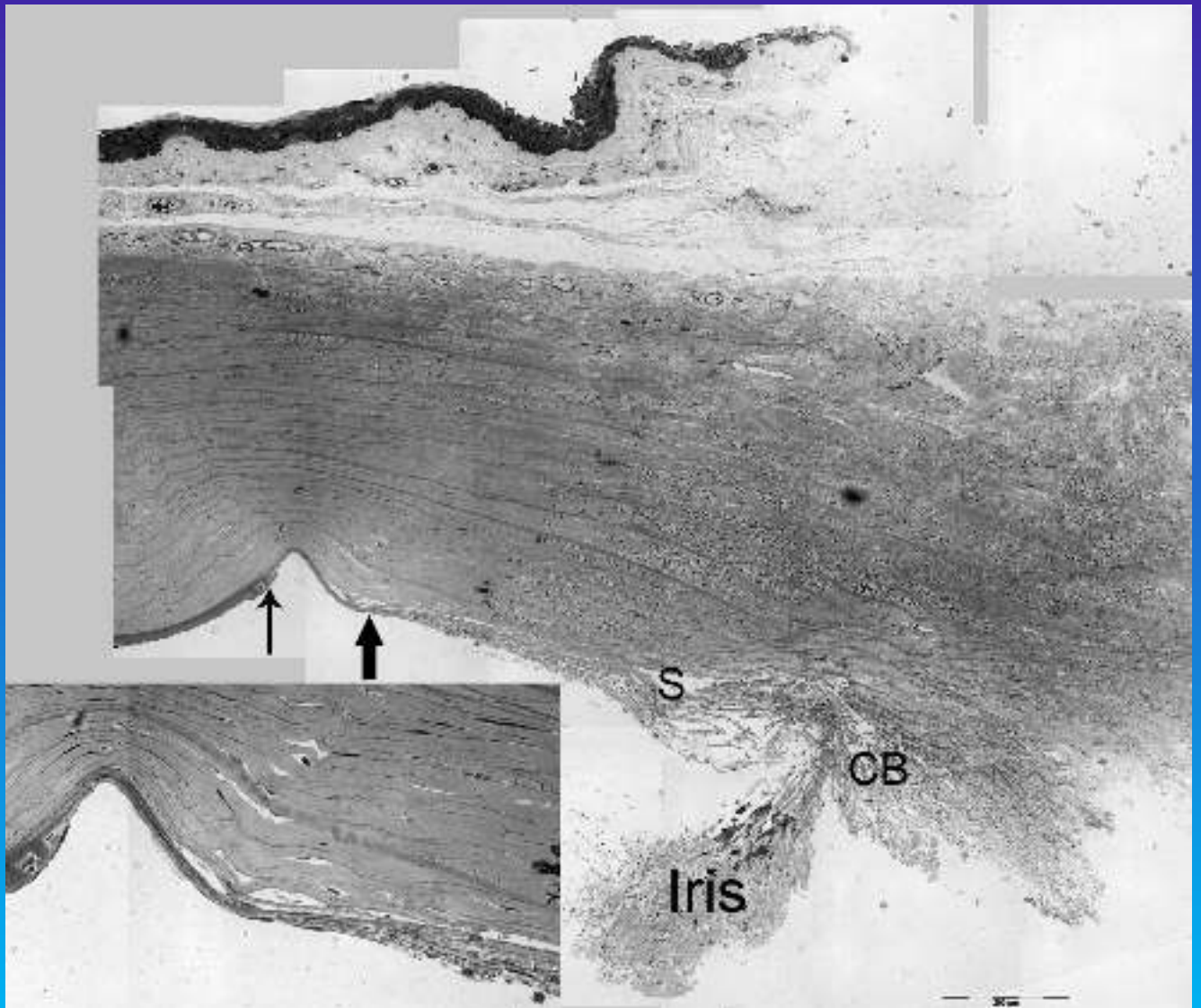
Type 1+Type 2 together
Partial or total

Usually starts at the periphery but can start at the edge of a T1 BB

Can be deflated by a needle puncture or a small nick

Science behind Type 2 and Mixed Bubbles

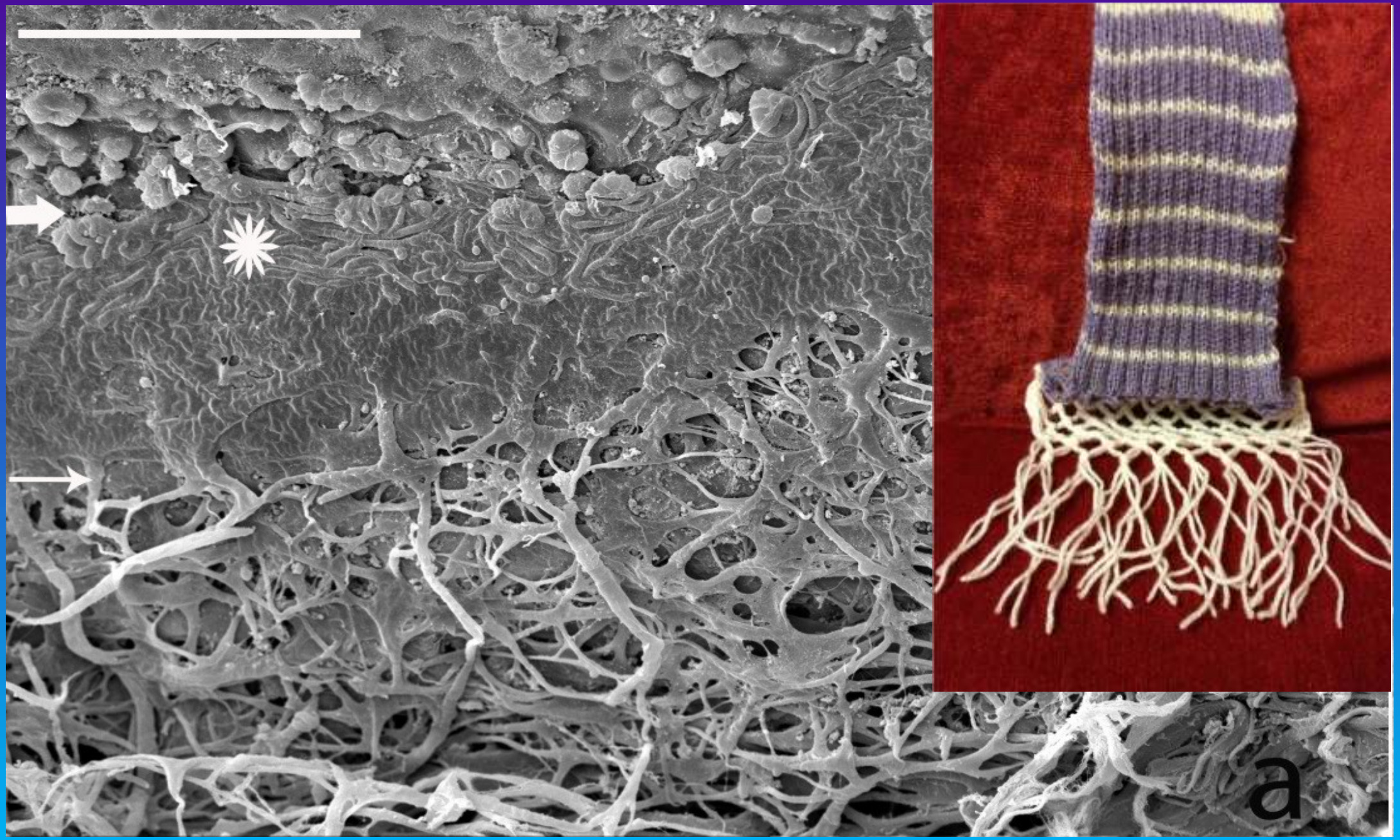
PDL and Trabecular meshwork: An unappreciated relationship



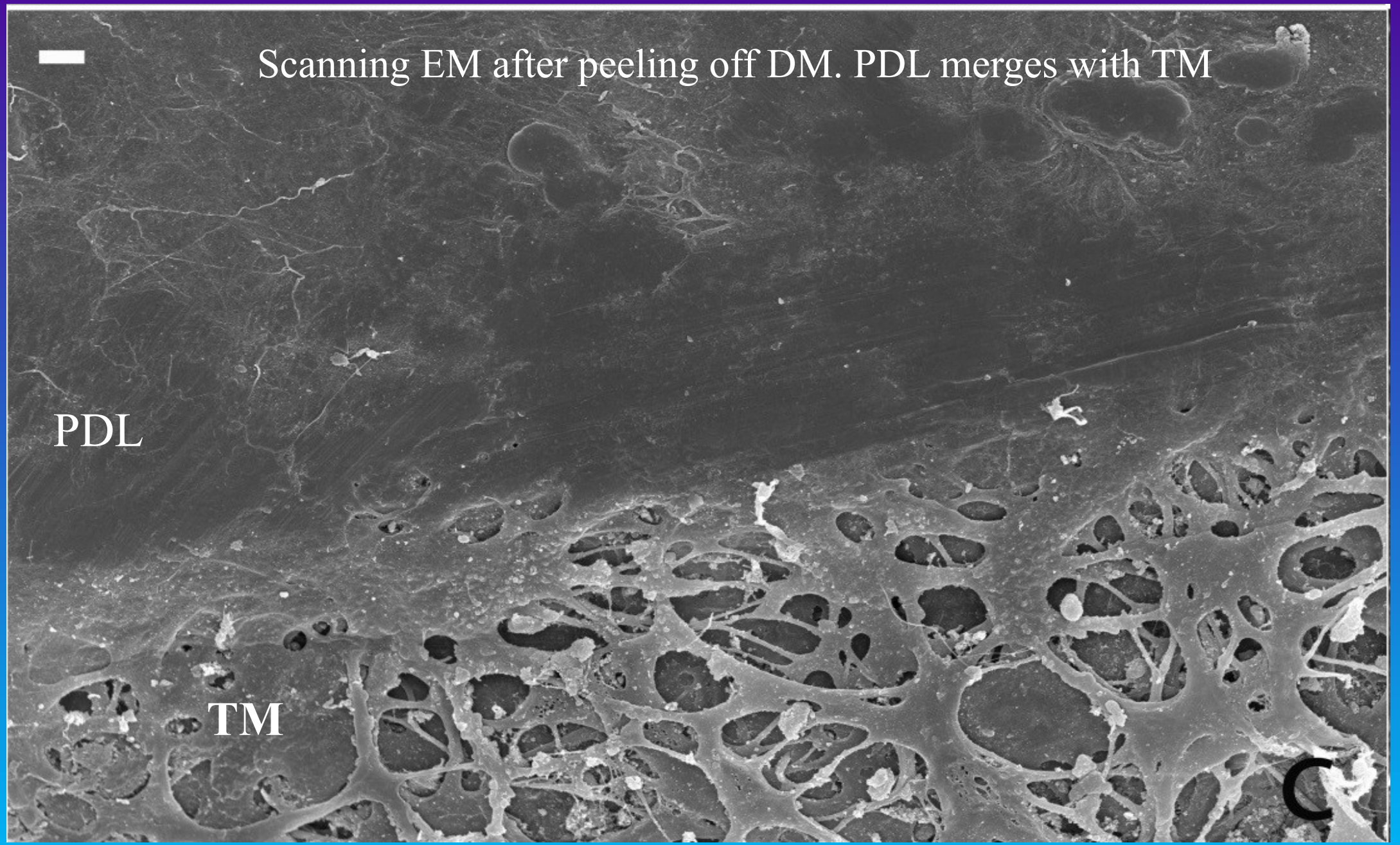
The PDL continues as the collagen core of the trabecular meshwork.

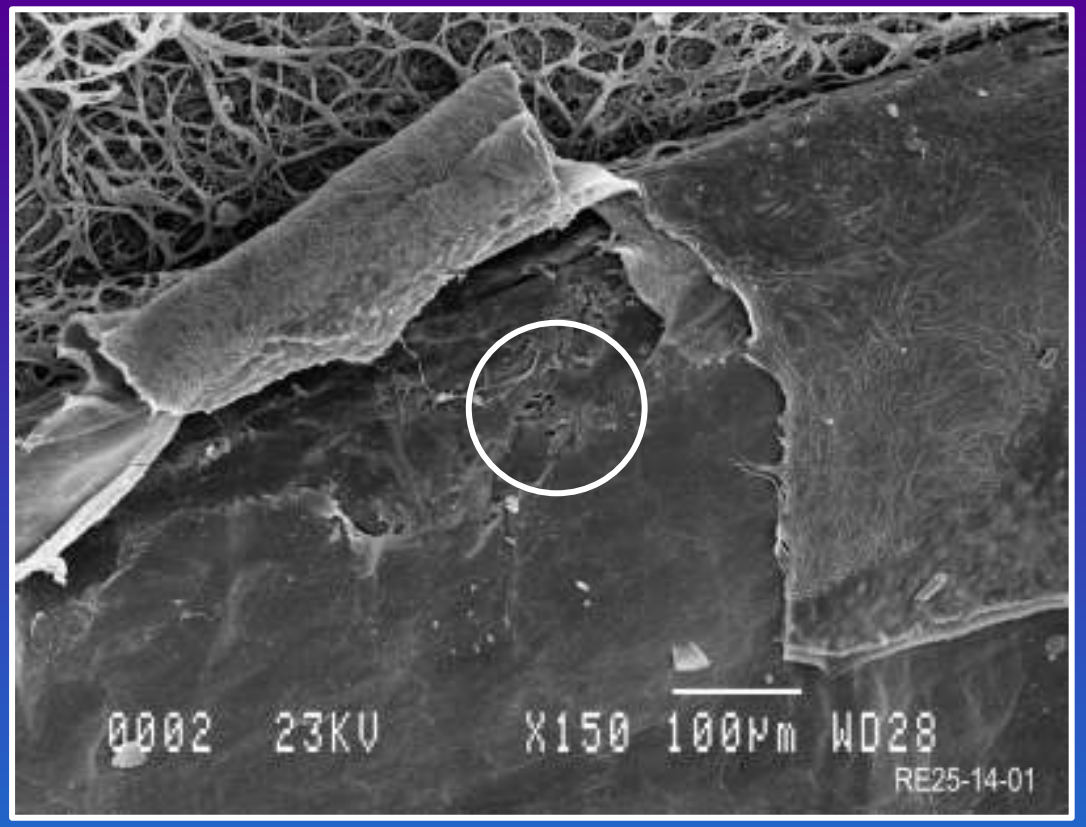
Dua HS, Faraj LA, Branch MJ, Yeung AM, Elalfy MS, Said DG, Gray T, Lowe J. The collagen matrix of the human trabecular meshwork is an extension of the novel pre-Descemet's layer (Dua's layer). Br J Ophthalmol. 2014 May;98(5):691-7. doi: 10.1136/bjophthalmol-2013-304593

Dua's Layer and Trabecular Meshwork

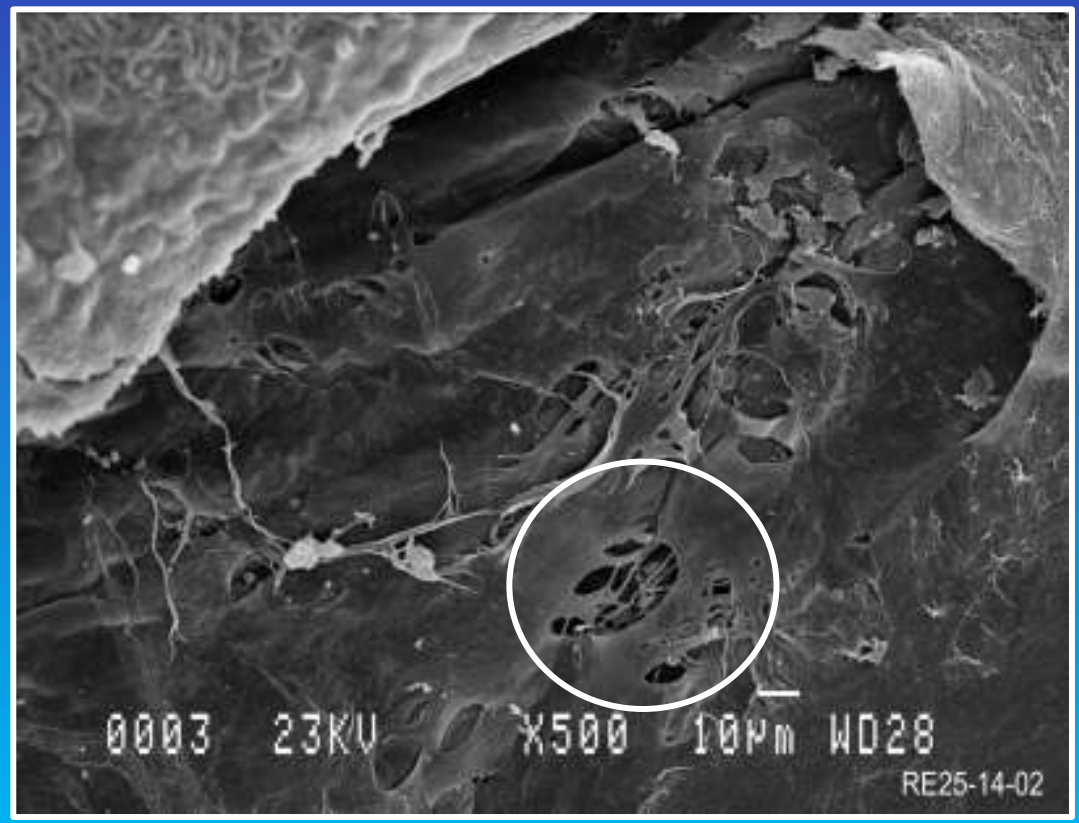


Science behind Type 2 and Mixed Bubbles



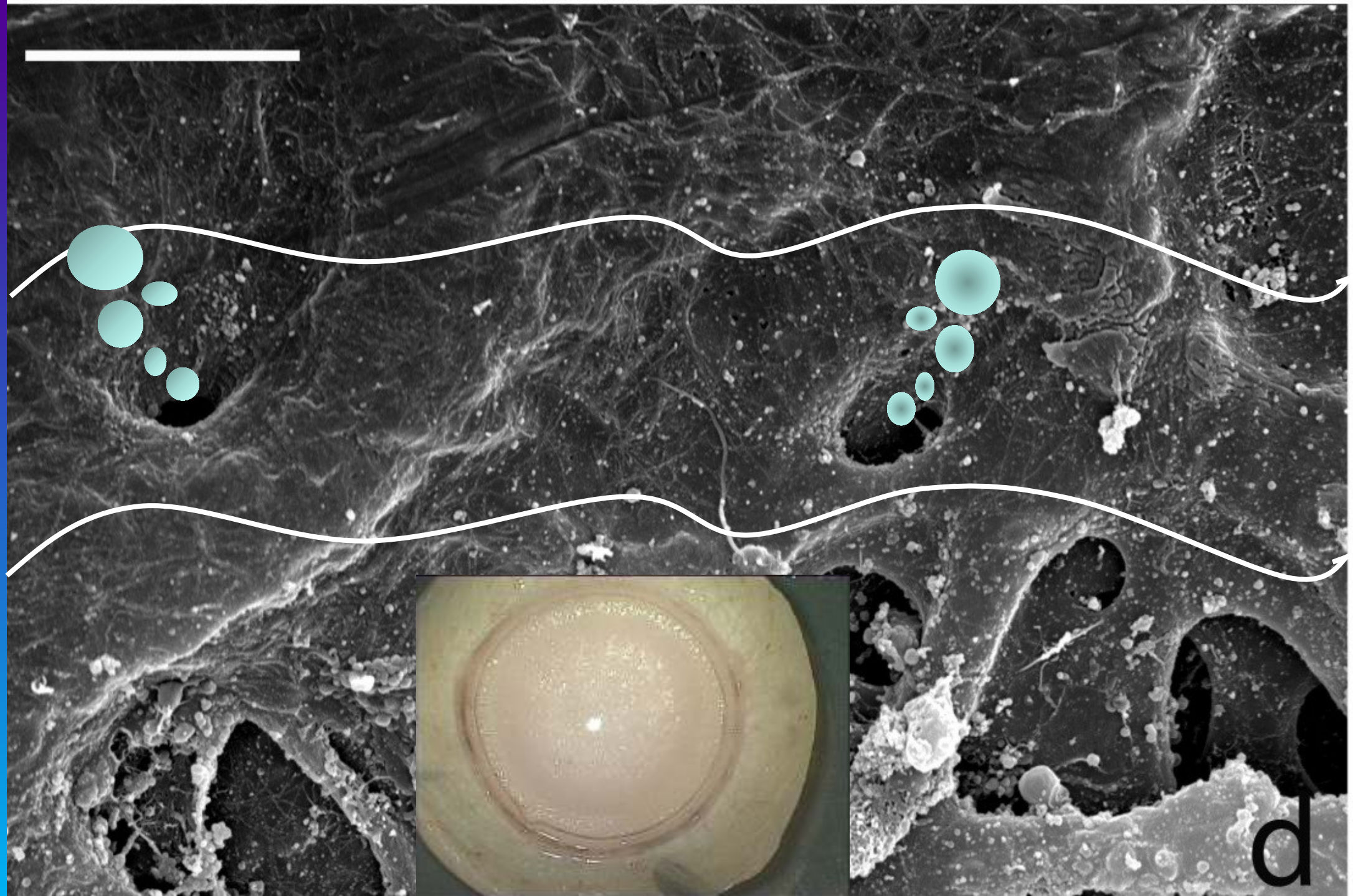


DL is impervious to air:
How does air pass through it to form a Type-2 BB?
How does air enter the AC?



SEM
Periphery of pre- Descemets layer (DL)

15-17 clusters of fenestrations, 5-60 microns (mean = 20 microns)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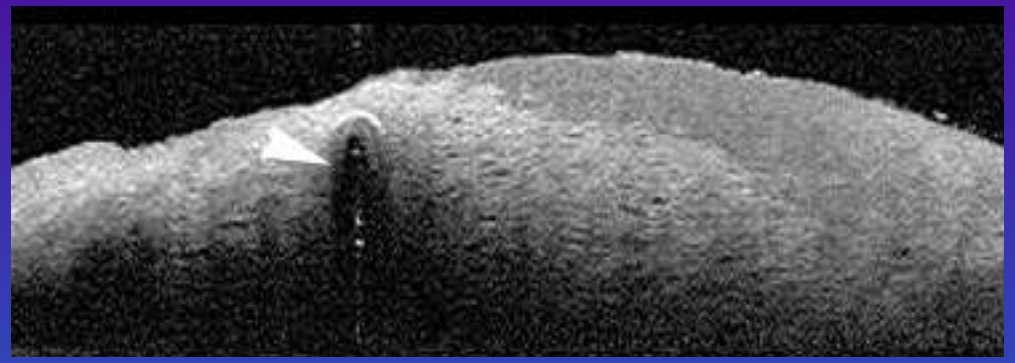
Lamellar Keratoplasty

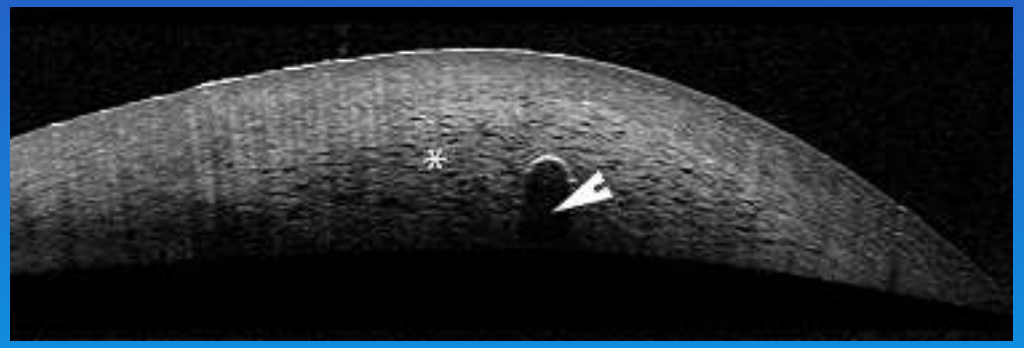
Deep Anterior Lamellar Keratoplasty

b. Visco-dissection

DALK – Visco-bubbles



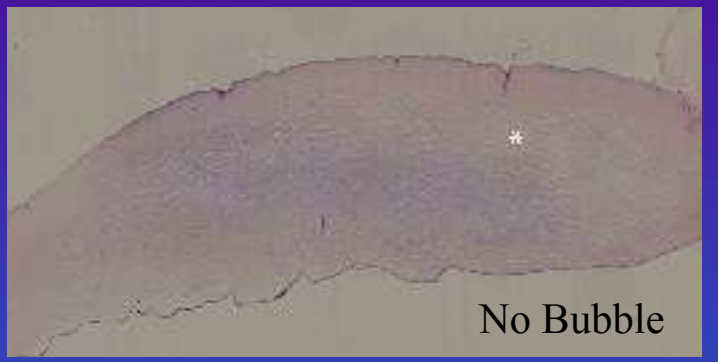
Viscoelastic injected in anterior third of corneal stroma

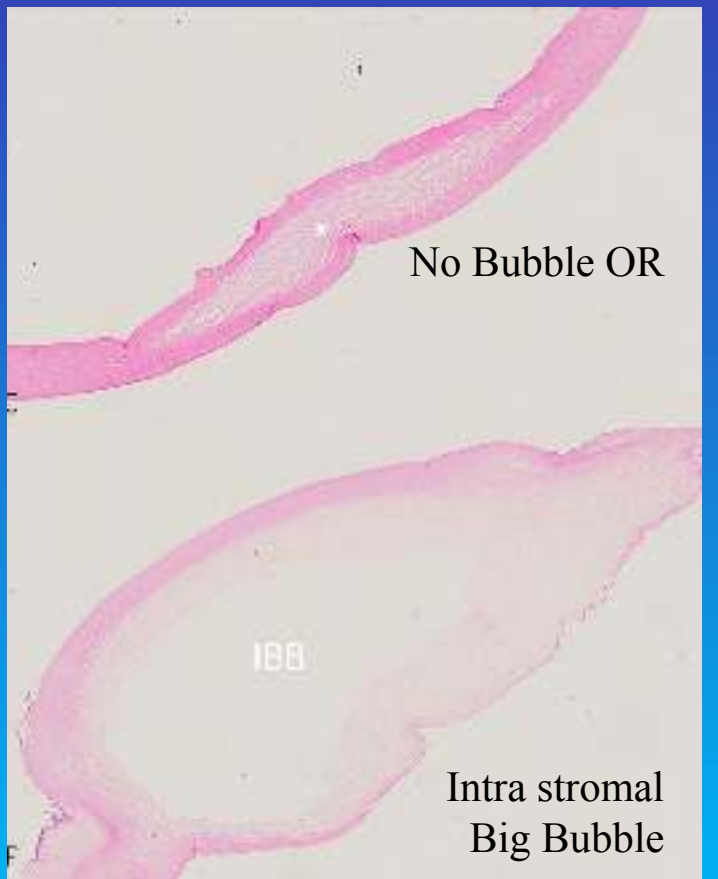


Viscoelastic injected in middle third of corneal stroma

Beware!

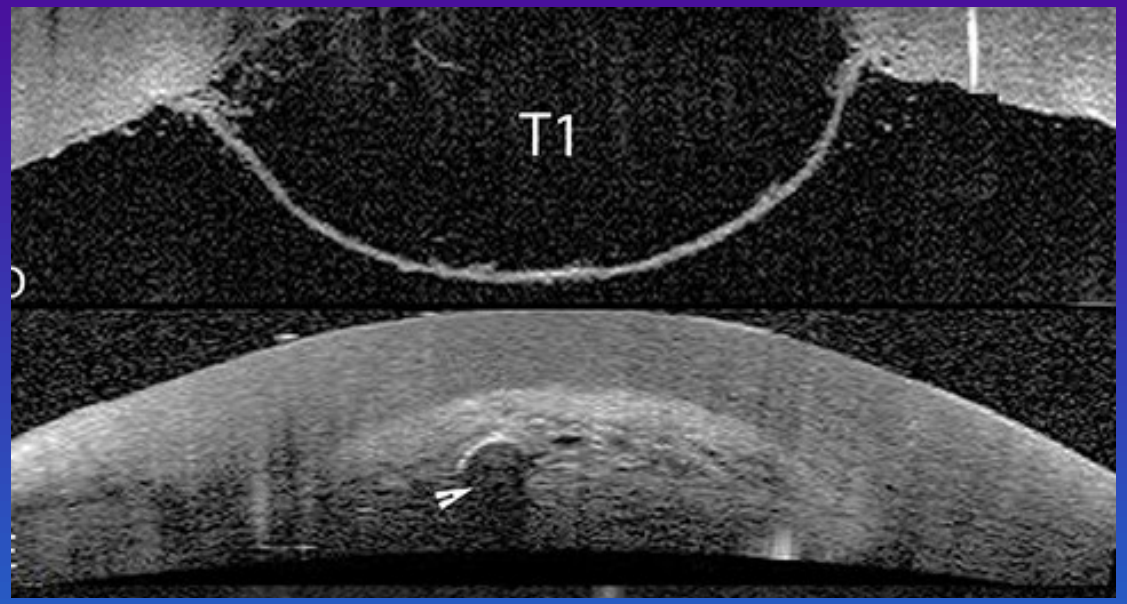
Intrastromal Big Bubble – a new entity



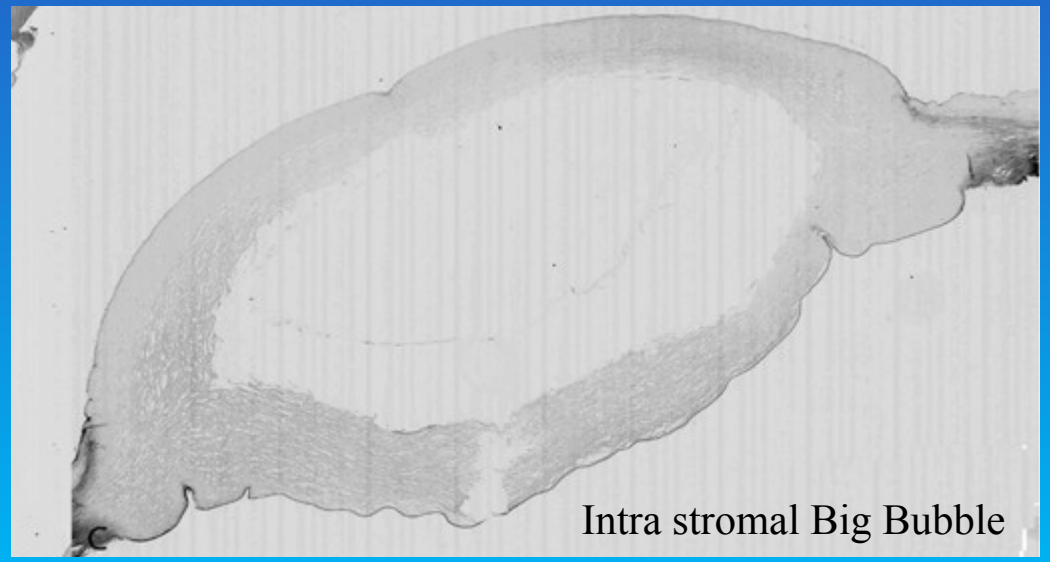


Ross A, Said DG, Dua HS et al. Br J Ophthalmol. 2018 Dec;102(12):1646-1652

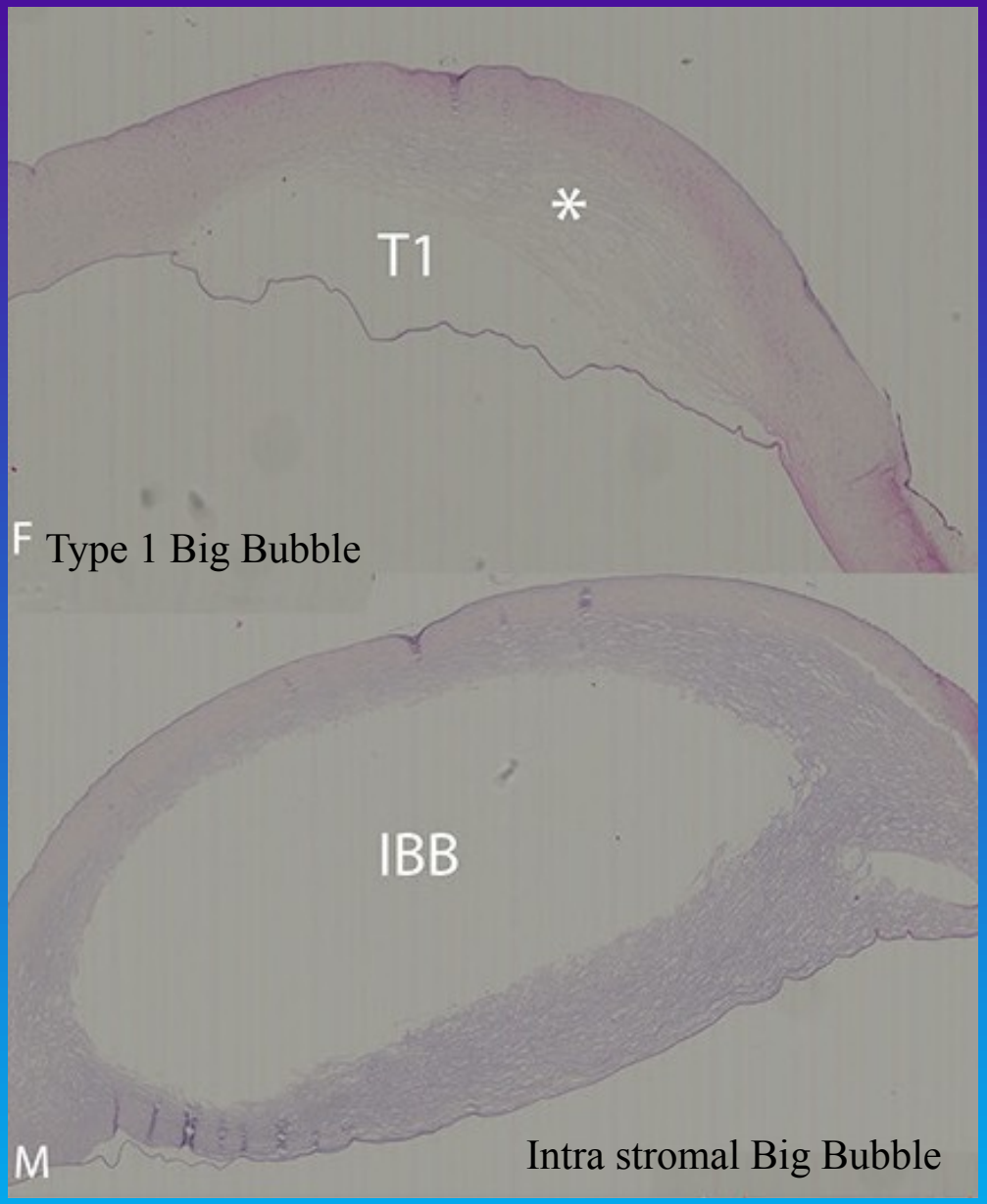
DALK – Visco-bubbles



Viscoelastic injected in posterior third of corneal stroma



Intrastromal big bubble – a new entity



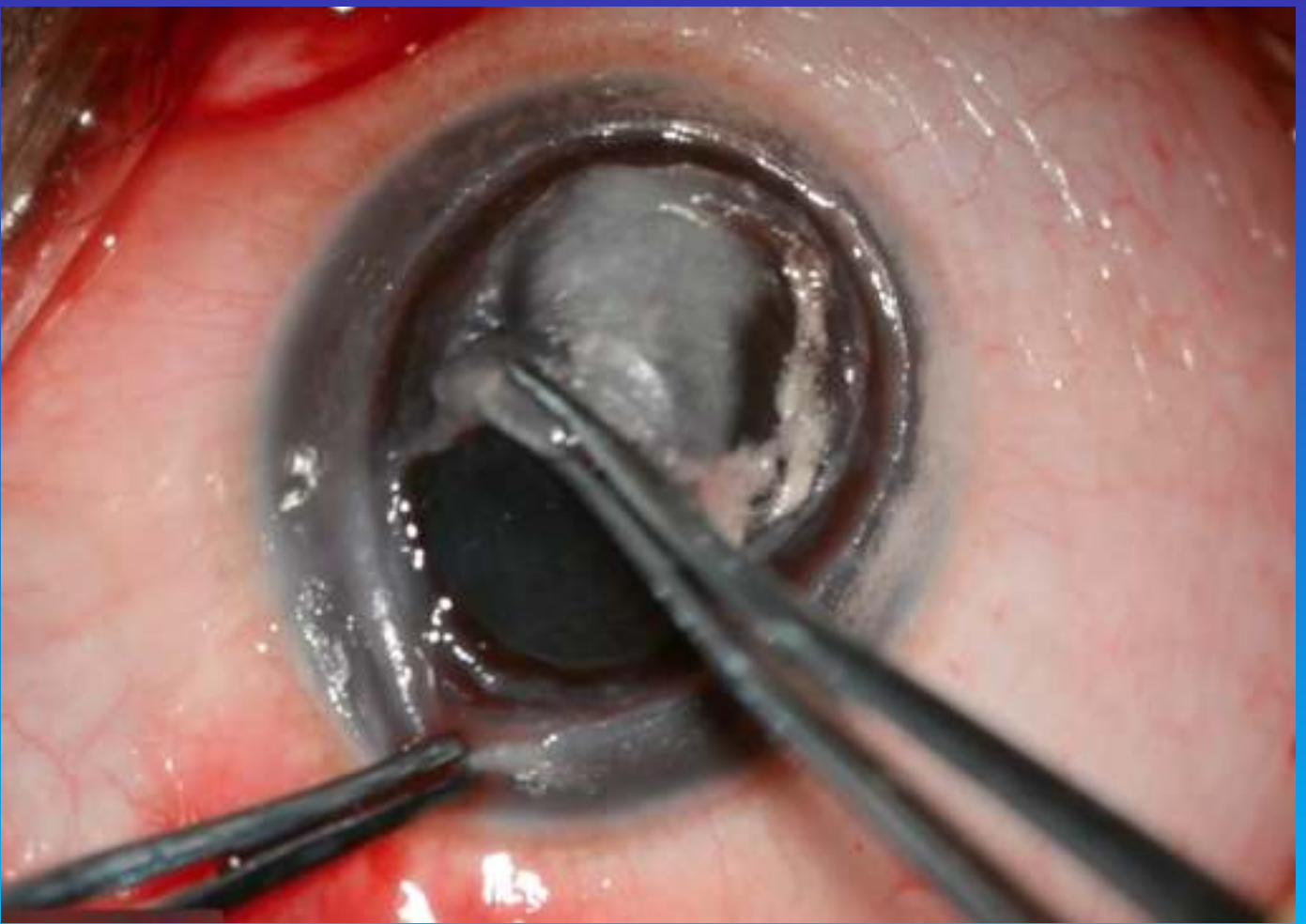
Ross A, Said DG, Dua HS et al Br J Ophthalmol 2018, online.

Lamellar Keratoplasty

Deep Anterior Lamellar Keratoplasty

c. Manual dissection

DALK – Exploiting the cleavage plane manually



- Failed attempt at Visco-bubble.

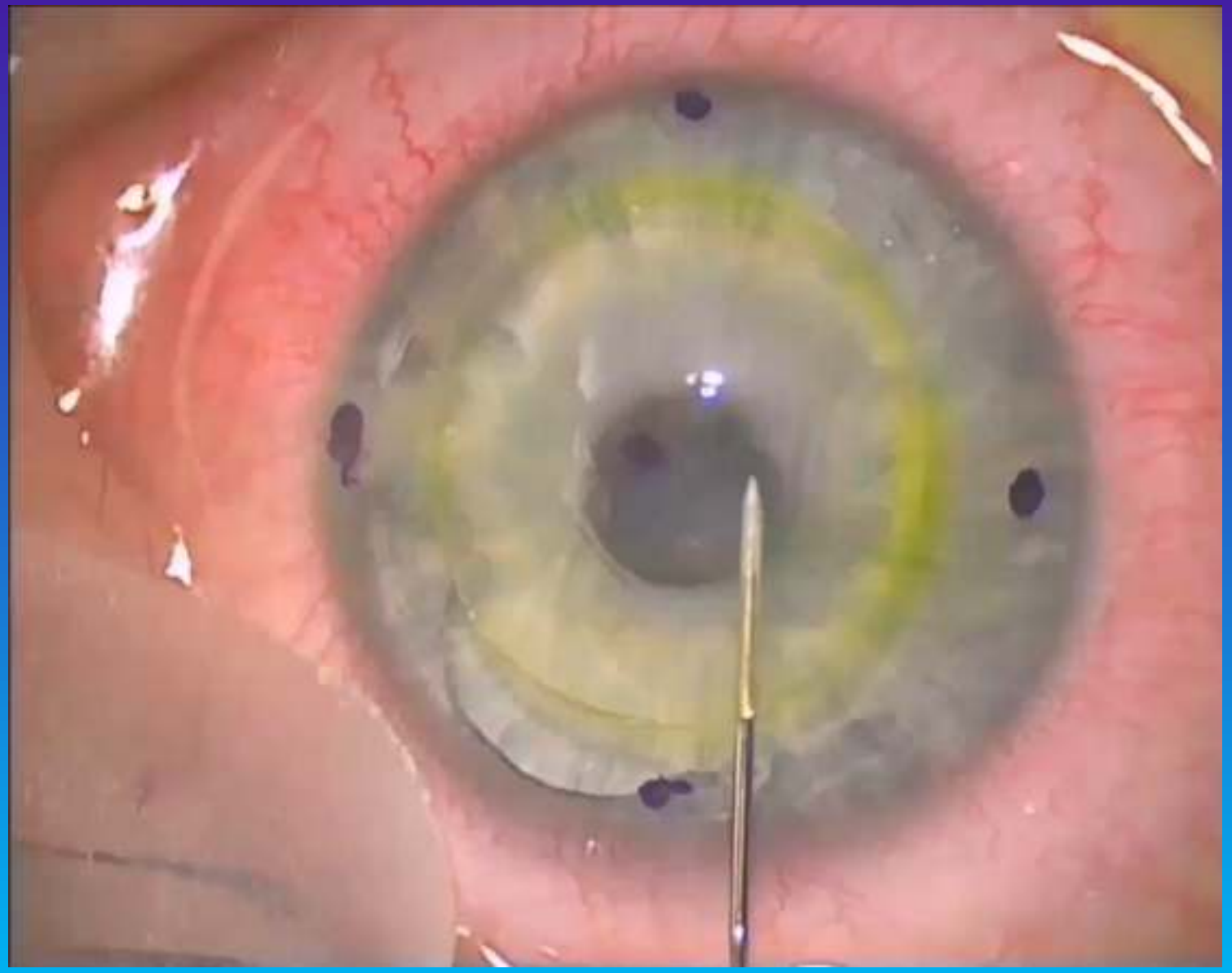
Tip

- Deep trephination.

- Stroma peeled off exploiting the plane of cleavage between Pre-Descemets layer and deep stroma.

Courtesy:
Dr Rishi Swarup
Swarup Eye Centre, Hyderabad, India.

DALK – Exploiting the cleavage plane manually



- Air injection in AC
- Try again elsewhere
- The PDL/DL plane can be exploited to reach anterior surface of the PDL/DL (Type-1BB)

DALK – Exploiting the cleavage plane manually

- Air injection in AC
- Try again elsewhere
- The PDL/DL plane can be exploited to reach anterior surface of the PDL/DL (Type-1BB) or Mixed!

Summary: DALK Science behind the Surgery

Knowledge of posterior corneal anatomy is key to understanding corneal surgery (and pathology)

The PDL, DM and Posterior corneal stromal relationship are important in lamellar keratoplasty, DALK and EK (DMEK and PDEK)

Helps in planning, designing, developing surgery; understanding complications and dealing with them

If we know Why we do What we do, we can do it better or find a better way of doing it. *hsd*

Queens Medical Centre, Nottingham.

THANK YOU