LA CORNÉE

PATHOLOGIES, TRAITEMENTS ET DISPOSITIFS MÉDICAUX

Pr David Touboul
PUPH, Ophtalmologiste
CHU Bordeaux

LE DINH Marie-Emma
Pharmacien assistant,
CHU Bordeaux

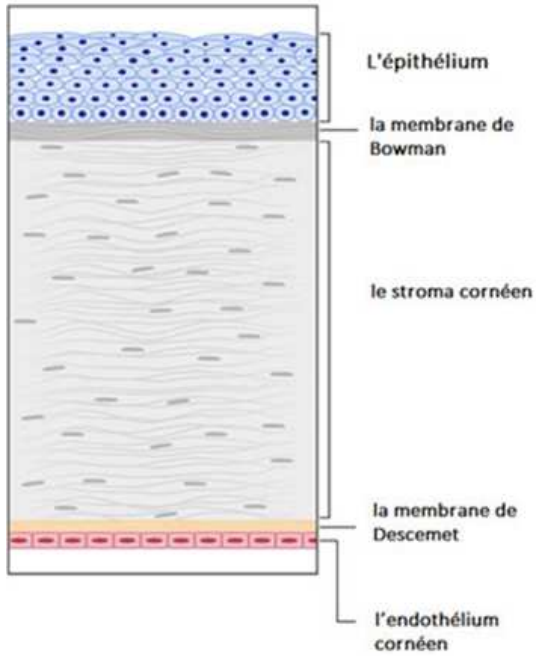
DÉCLARATION DE LIENS D'INTÉRÊT

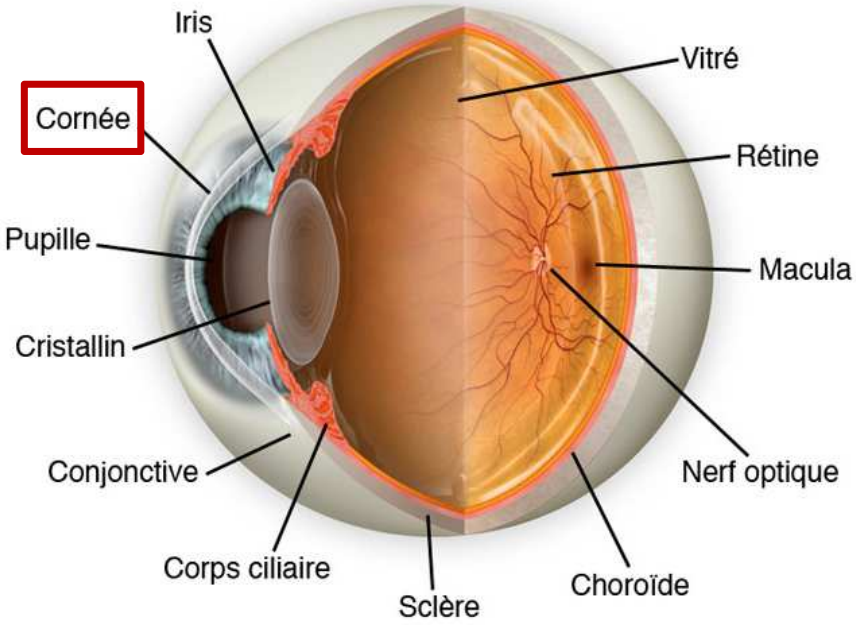
Aucun lien d'intérêt à déclarer

LA CORNÉE

- Tissu transparent

- 5 couches :

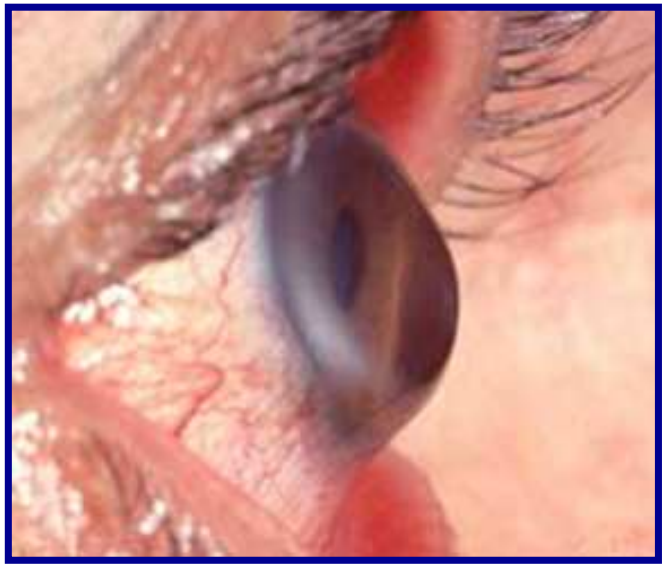




- Nombreuses pathologies affectant sa forme et/ou sa transparence

KC = CORNÉE FRAGILE

Susceptible de se déformer PROGRESSIVEMENT



- Spontanément

- Au décours d'une chirurgie cornéenne (EPL)

KÉRATOCÔNE : FACTEURS DE RISQUE

- Génétique : 6 à 21%
- Frottements
- Atopie (AKC – VKC)
- Inflammation

  MMP-13; IL6 ; TNF alpha
- Environnement
- Maladies du collagène
- LASIK

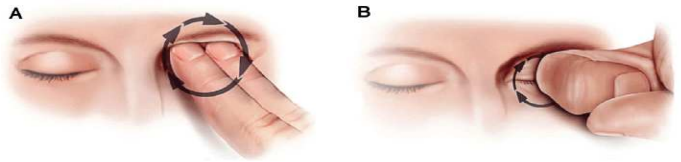


Figure 1. Patients with keratoconus use their (A) finger tips or (B) knuckle to generate pressure localised to the cornea in a circular motion. Images reproduced with permission from Dr Alan Carlson.[13]

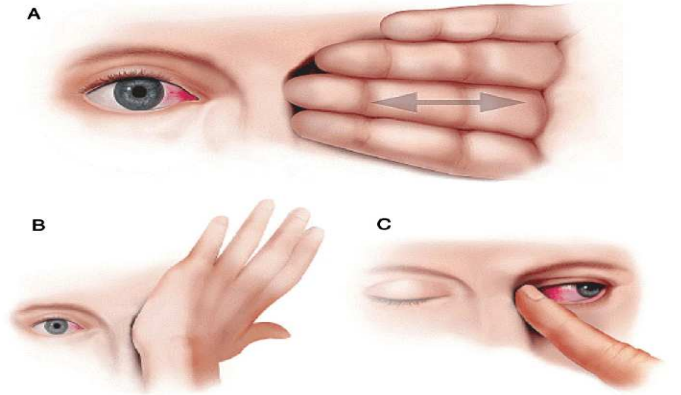
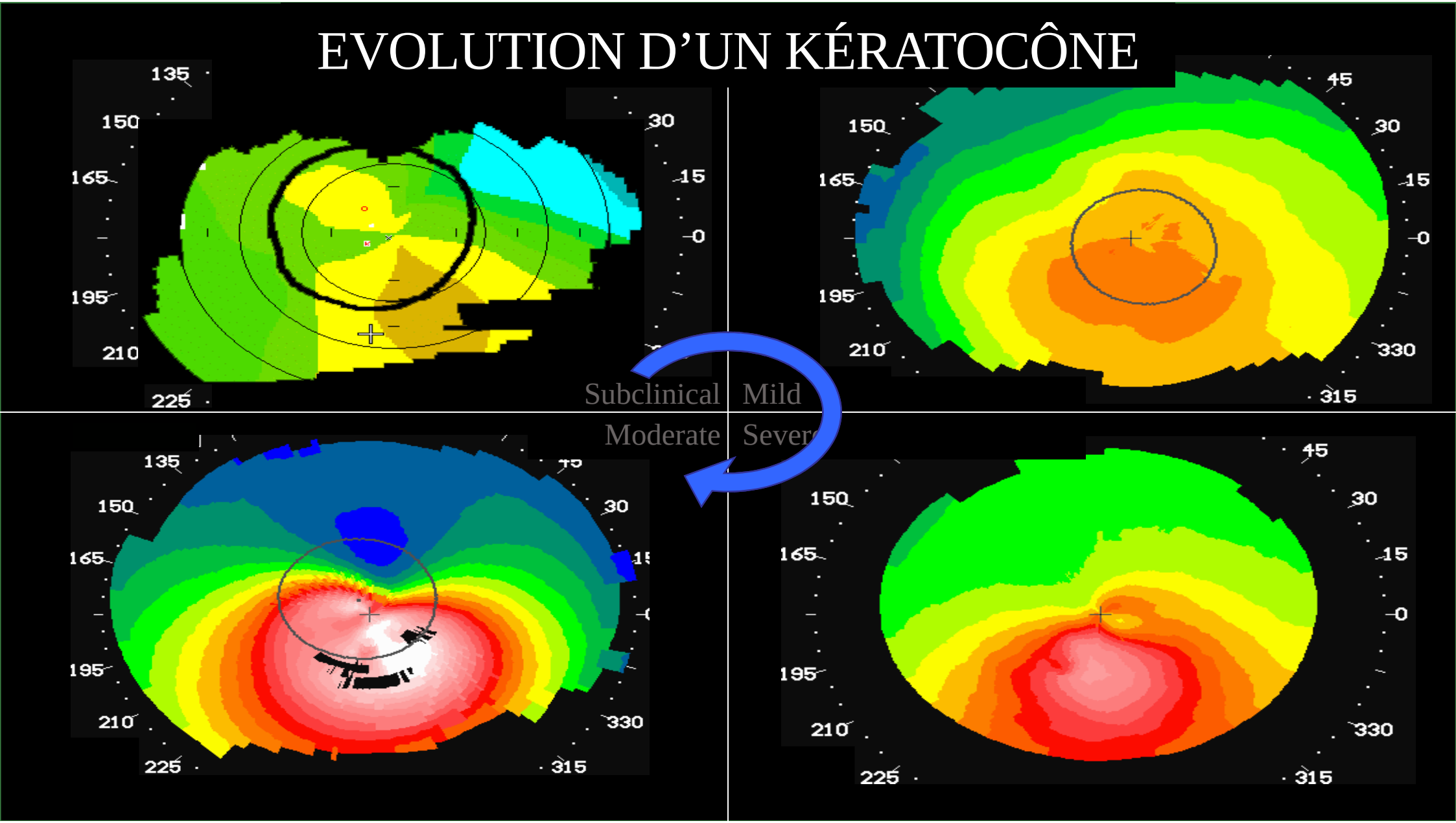


Figure 2. Different methods adopted by allergic patients for eye rubbing using (A) the back of the hand, (B) the palm and (C) the finger pad involving the caruncle. Images reproduced with permission from Dr Alan Carlson.[13]



EVOLUTION D'UN KÉRATOCÔNE



Prise en charge du KC

Stopper la Progression

CXL

Limiter les AOS

LR est le meilleur choix
Cornéoplasties séquentielles



Eviter la Keratoplastie

Dernier recours

Corriger les AOI

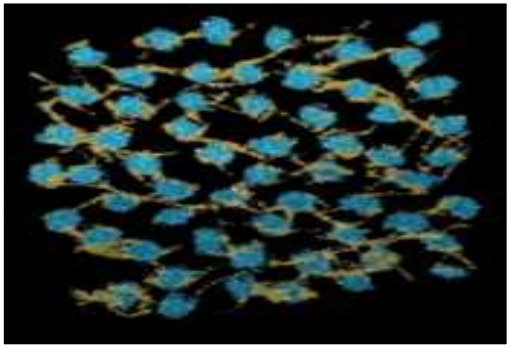
Lunettes / Lentilles
ou IOL

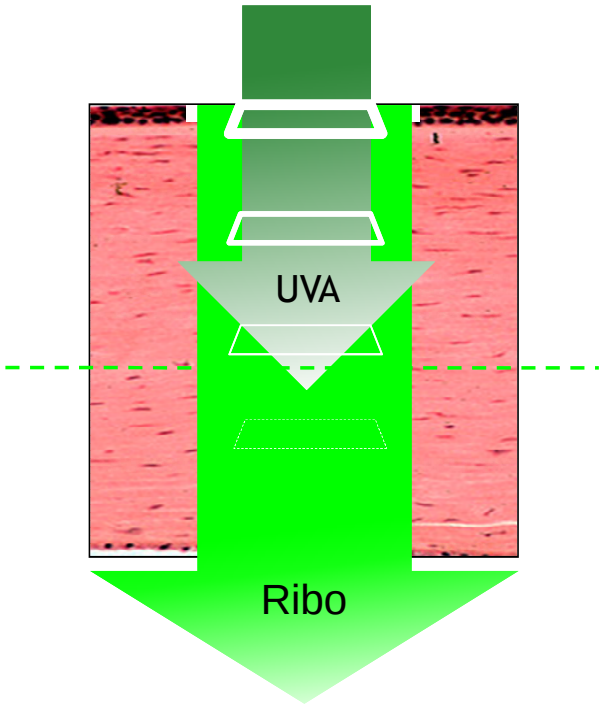
CORNEAL CROSS-LINKING : CXL

Interaction Photo-chimique

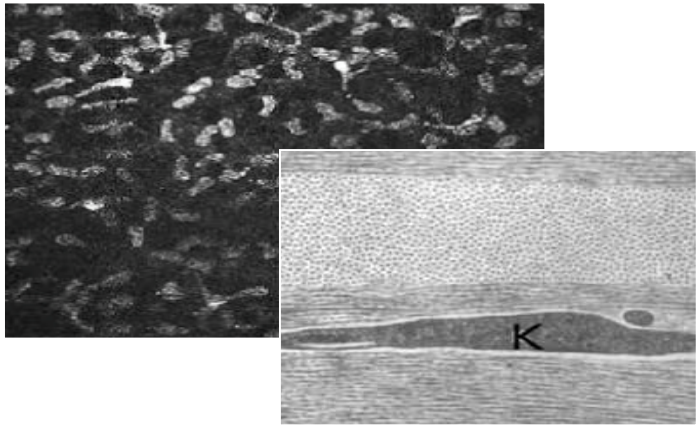
Riboflavine/UV-A/Stroma Cornéen

Photo-Réticulation



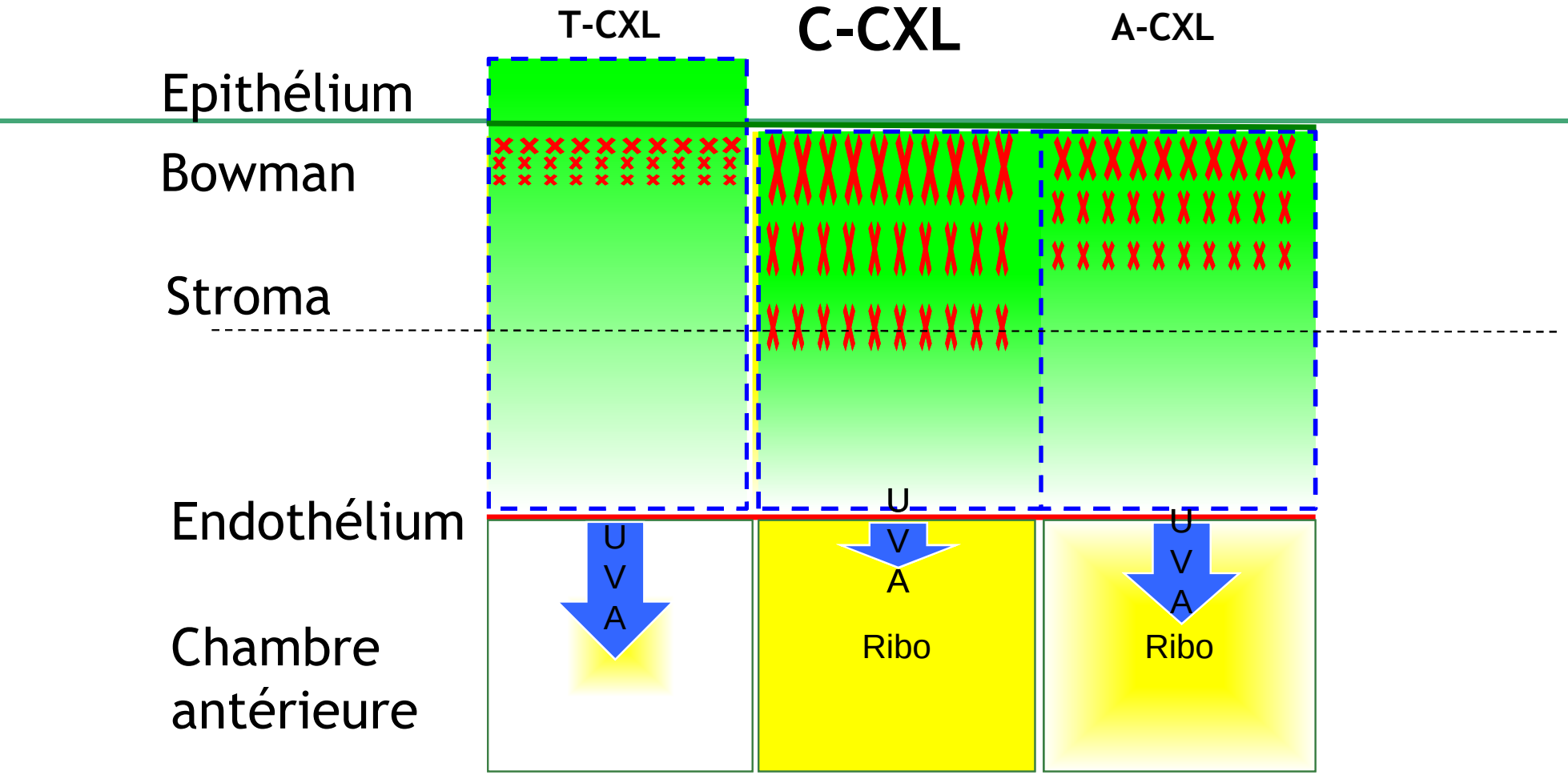


Renouvellement Cellulaire

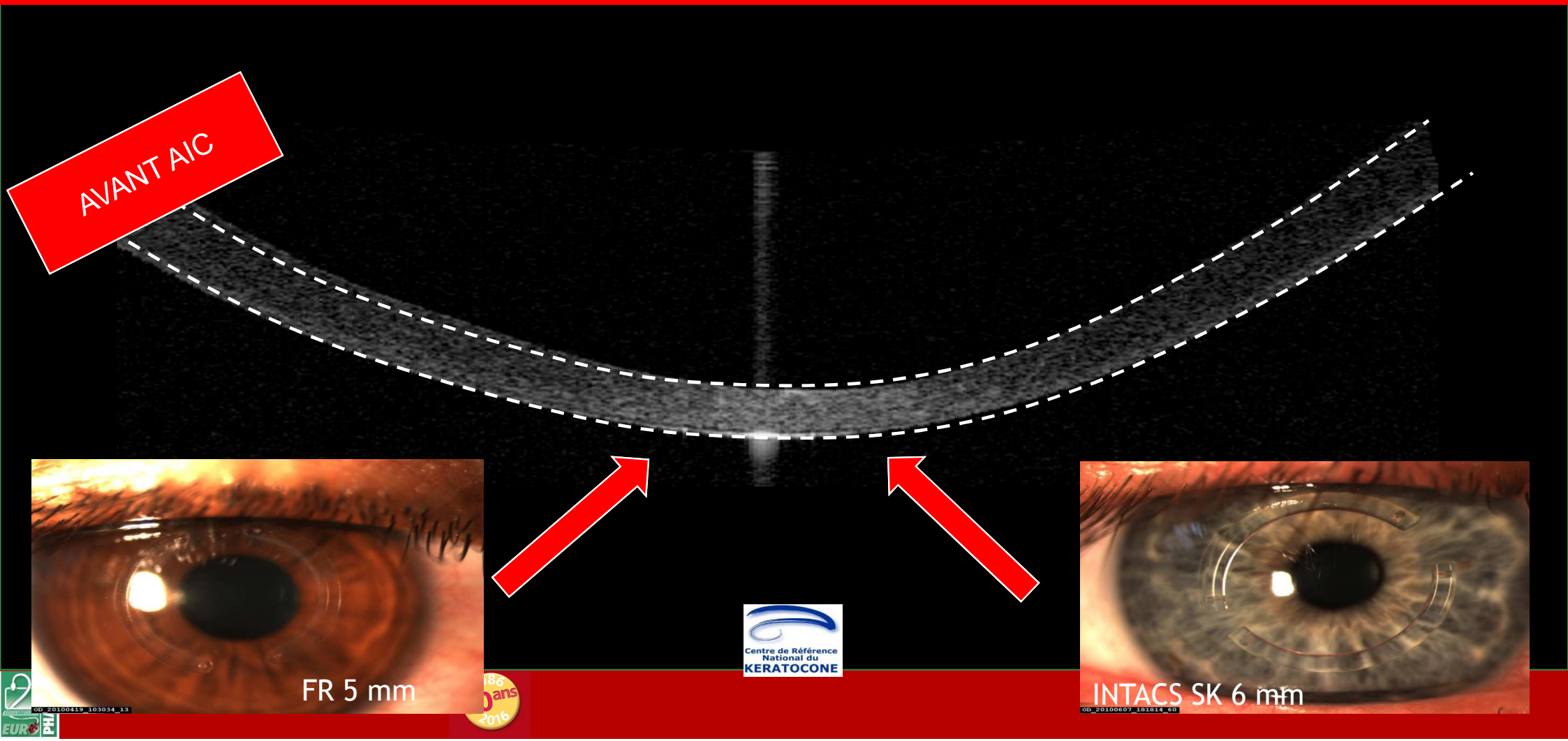


Stabilisation de la Maladie

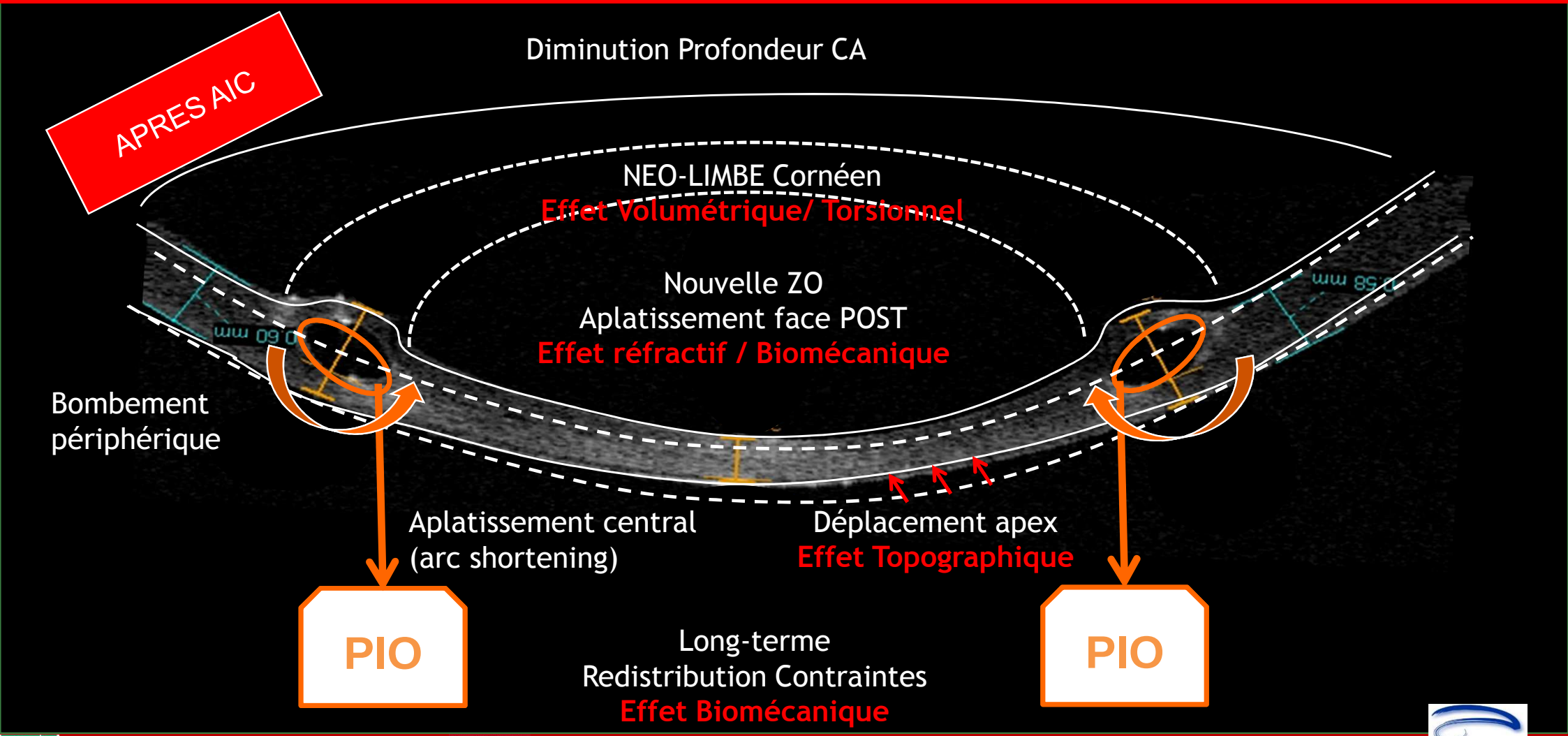
DÉCLINAISONS PROTOCOLES CXL



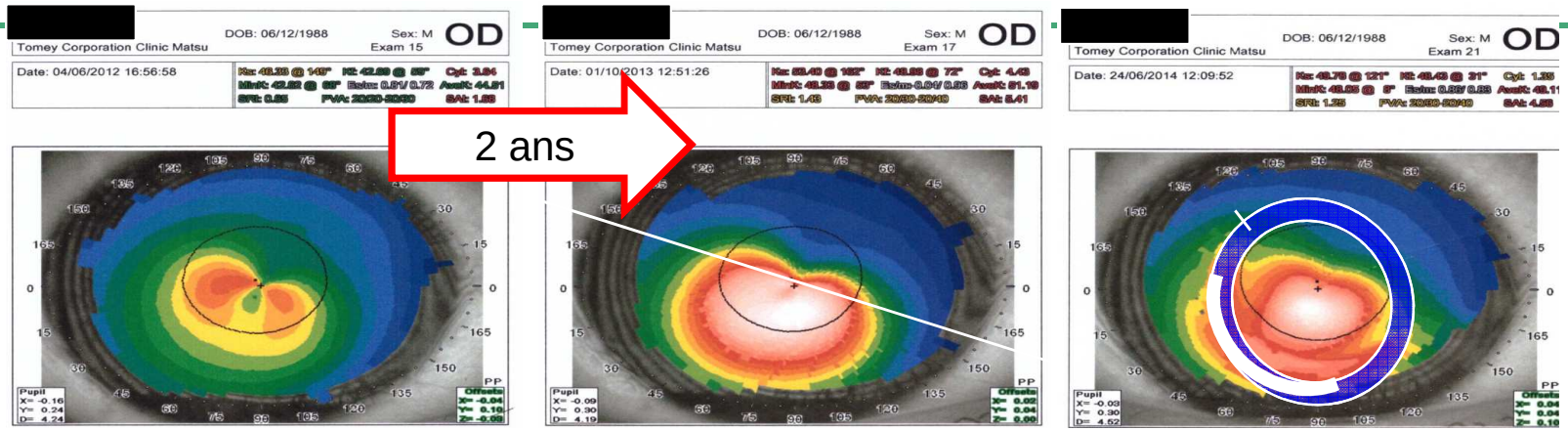
Anneaux Intra Cornéens



AIC


APRES AIC
Diminution Profondeur CA
NEO-LIMBE Cornéen
Effet Volumétrique/ Torsionnel
Nouvelle ZO
Aplatissement face POST
Effet réfractif / Biomécanique
Bombement périphérique
Aplatissement central (arc shortening)
Déplacement apex
Effet Topographique
PIO
PIO
Long-terme
Redistribution Contraintes
Effet Biomécanique

KC TRES EVOLUTIF : AIC + CXL



TRES EVOLUTIF

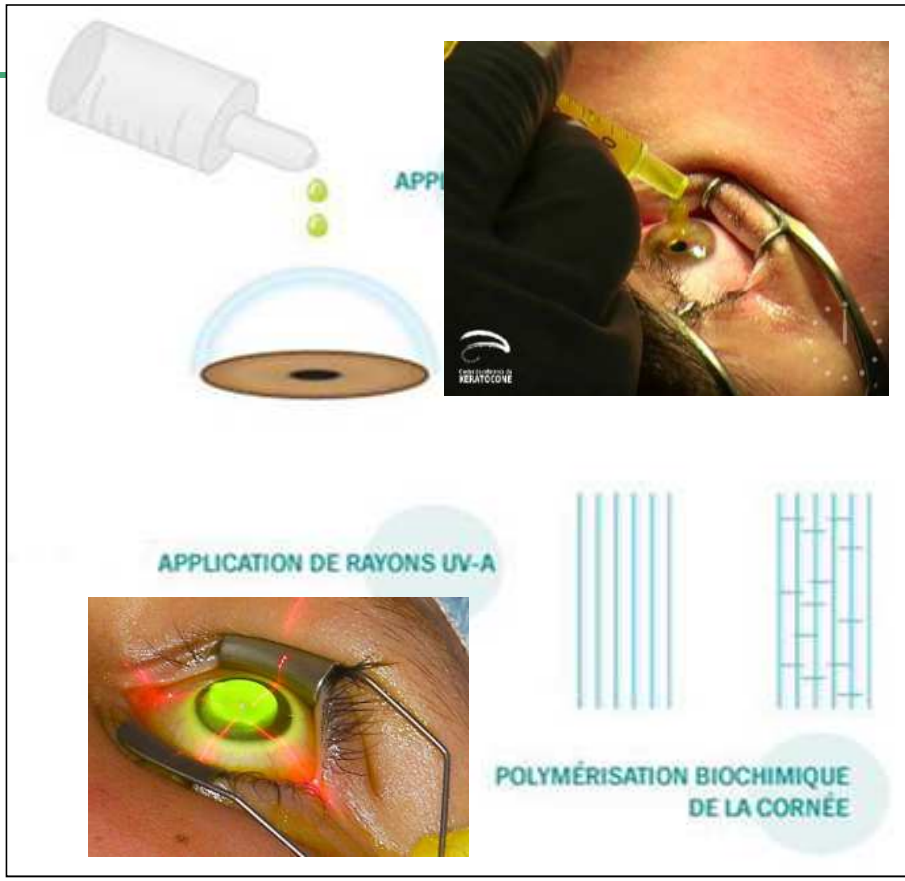
Ferarra ring 5 mm
160° x 300 X 1

	PRE OP	PRE OP + 2 Years	AIC + CXL
Courbure : Kmax (D)	46,3	53,4	49,7
Astigm : CYL (K)	3,6	4,4	1,3
Acuité	20/20	0.3 (20/60)	0.7 (20/30) -1,5(-3)110°

DM pour CROSS-LINKING (CXL)

- **Photoréticulation du collagène cornéen**
- **Protocole de Dresde** (Conventionnel) EPI OFF
- **Riboflavine +/- Lentille d'imprégnation**
  - Ribloflavine 0,1% (= Vitamine B2) : DM classe IIb
- **Lampe UVA 375 nm**
  - Absorbtion par riboflavine
  - Libération radicaux libres
  - Pontage du collagène
  - Cicatrisation / LSH





DM pour CROSS-LINKING (CXL)



Ricrolin TE ® (Horus)

- **Protocole conventionnel** : riboflavine à 0,1% et de Dextran T500

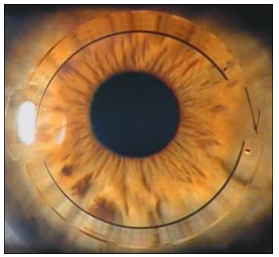
- **Protocole rapide** : riboflavine à 0,1% et Hydroxy-Propyl-Méthyl-Cellulose (HPMC)
  - Taux de diffusion de 2 fois celui de la riboflavine standard

- **Protocole trans-épithélial (TE)** : riboflavine à 0,1 ou 0,25%, Dextran ou HPMC, Agents de vectorisation (BAC = benzalkonium, EDTA = acide édétique, TRIS = trométamol)
  - Pas de désépithélialisation de la cornée



Vibex Rapid® (Emetrop)

DM pour ANNEAUX INTRA-CORNEENS



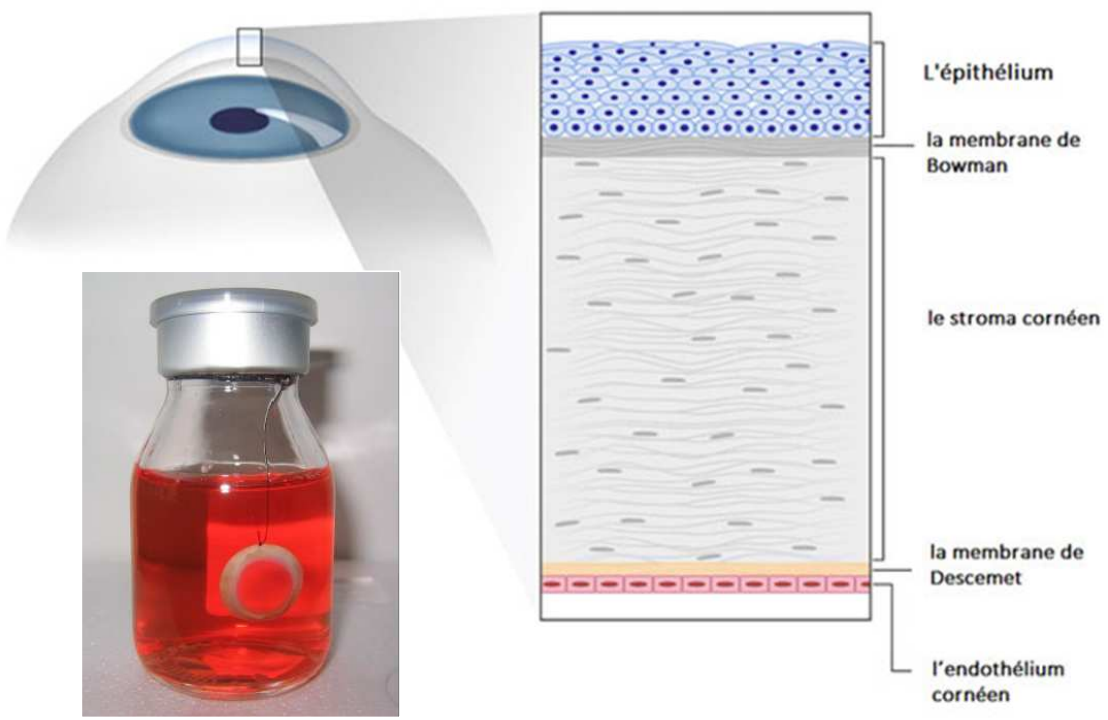
- Description : Segments semi-circulaires en Polyméthacrylate de méthyle (PMMA), introduits dans un tunnel cornéen réalisé au laser femtoseconde
- Choix selon topographie & abaques, au cas par cas
- Multiplicité
  - Fournisseurs
  - Diamètre
  - Section
  - Longueur d'arc
  - Épaisseur





	FERRARA RING®	KERARING®	KC SEGMENTS®	INTACS®	INTACS SK® (SK = Kératocône sévère)
Fabricant	**Ferrara Ophtalmics**	**Médiphacos**	**KC Solutions**	**Addition Technology**	**Addition Technology**
Epaisseur (µm)	150-350 Incrémentation par pas de 50 µm	150-350 Incrémentation par pas de 50 µm	150-350 Incrémentation par pas de 50 µm	210, 250, 300, 350, 400, 450	210, 250, 300, 350, 400, 450, 500
Forme de la coupe transversale	**Triangulaire**	**Triangulaire**	**Triangulaire**	**Hexagonale**	**Ovale**
Diamètre interne (mm)	5 et 6	5, 5.5 et 6	5 et 6	7	6
Longueur d'arc (°)	90, 120, 140, 150, 160, 180, 210	90, 120, 150, 160, 210, 340 et 355	90, 120, 150, 160, 180, 210	150, 210	90, 130, 150

GREFFES DE CORNEES



Greffe transfixiante (KT)

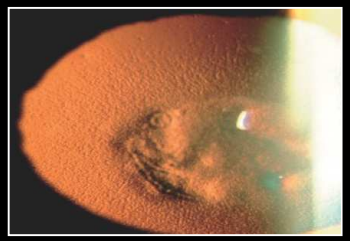
Kératoplastie Lamellaire Antérieure Profonde (KLA-P)

Kératoplastie Lamellaire Postérieure Endothéliale (KLP) : DSEAK et DMEK

A chacun sa greffe !



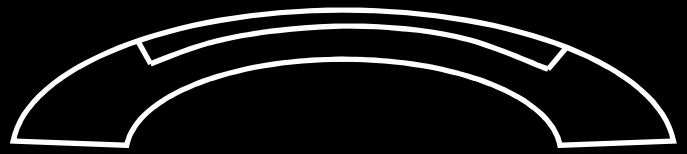




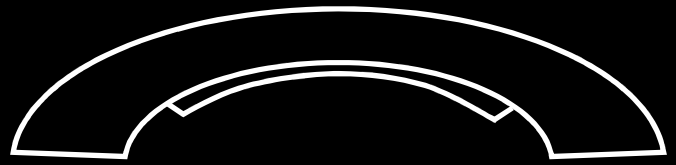




Kératoplastie Lamellaire Antérieure Profonde
KLAP



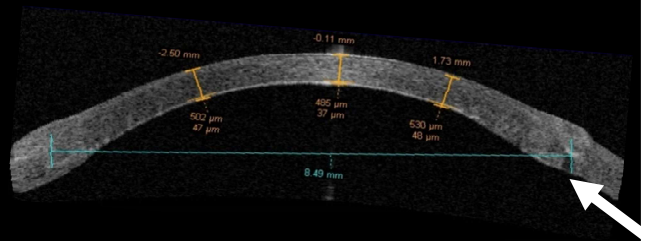
Kératoplastie Lamellaire Antérieure
KLA



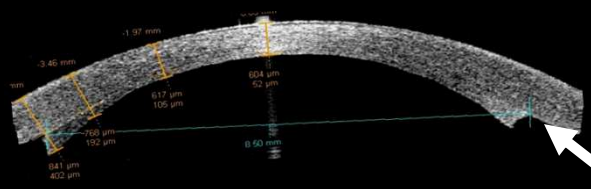
Kératoplastie Lamellaire Postérieure
KLP

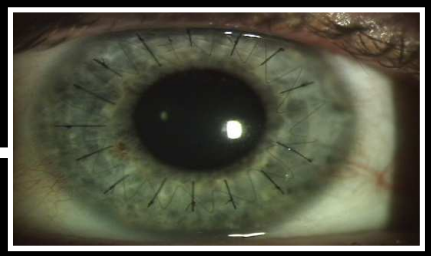


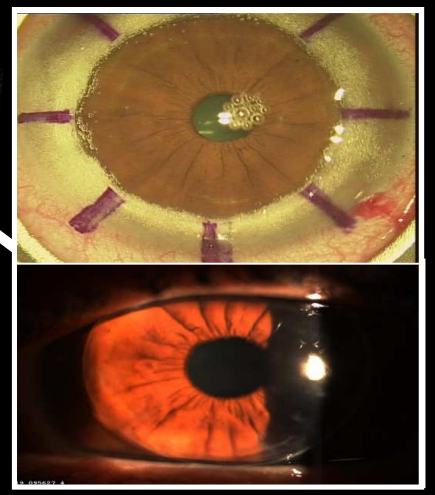
Transfixiantes
KT

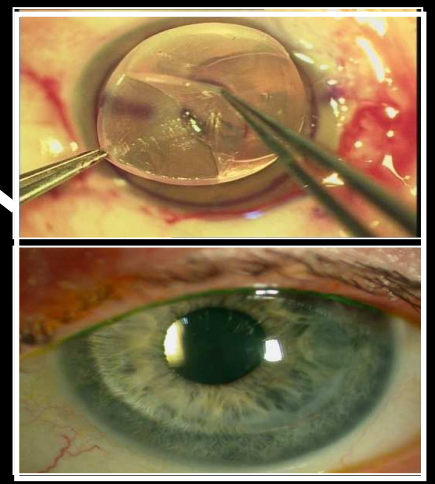






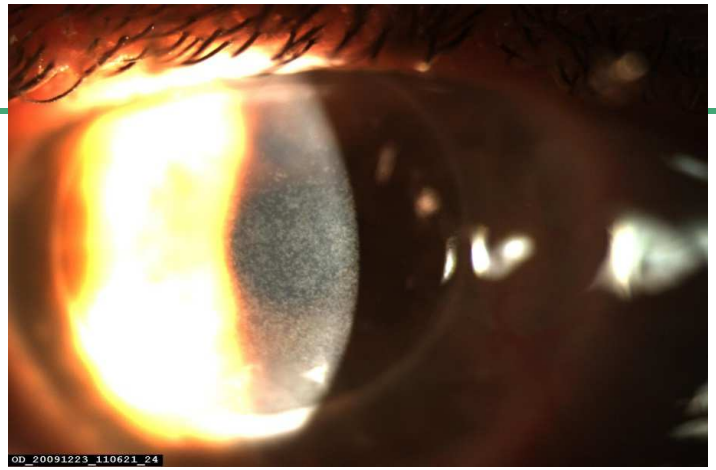






Greffes transfixiantes : complications

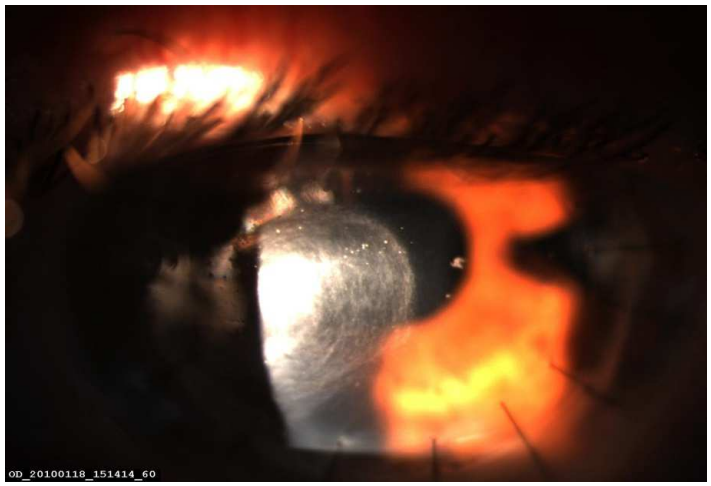
Sécheresse

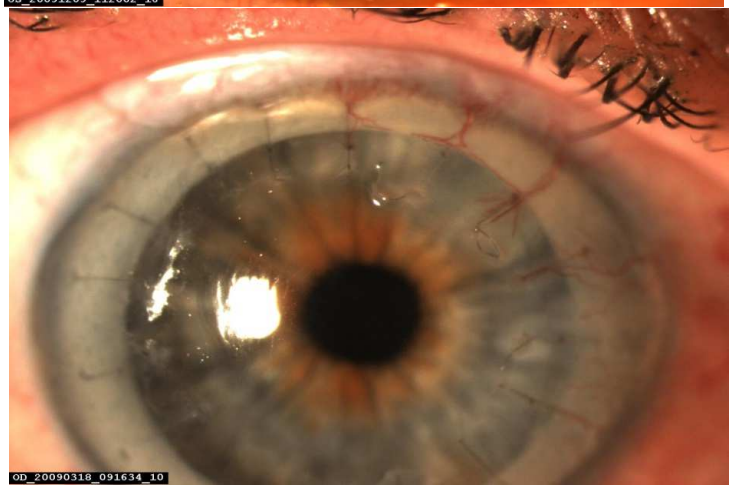




Rejet

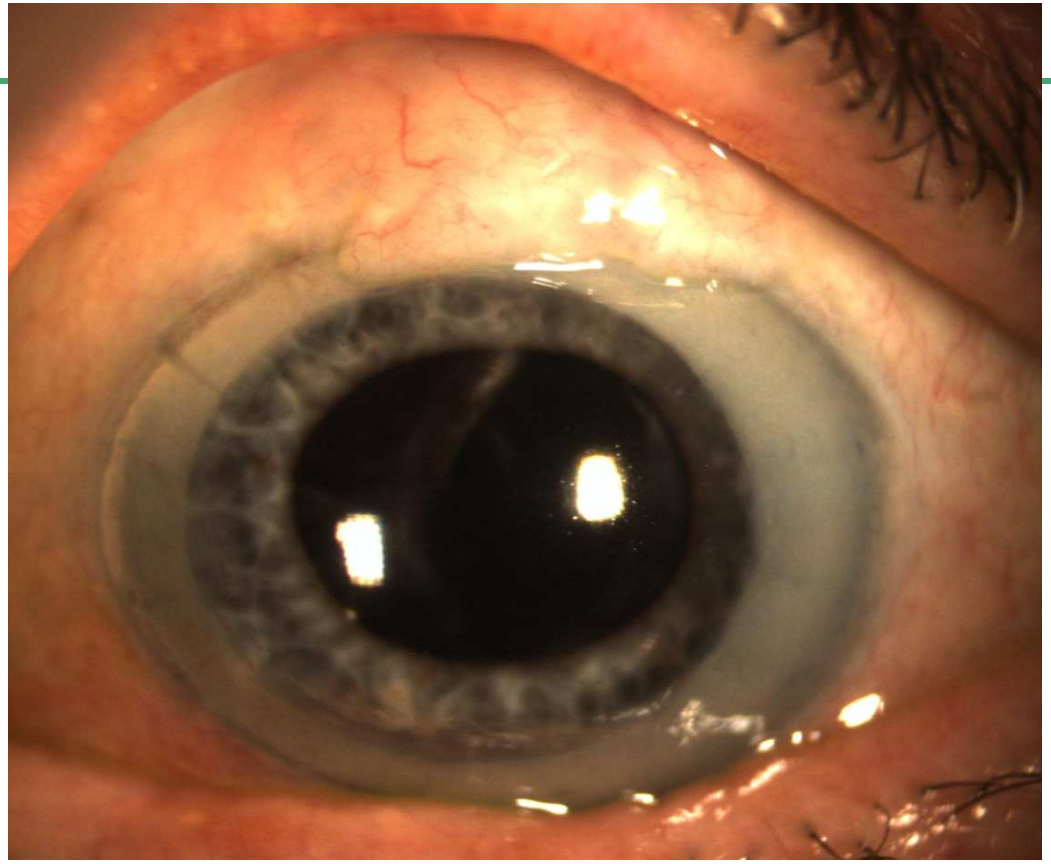
Troubles cicatrisation





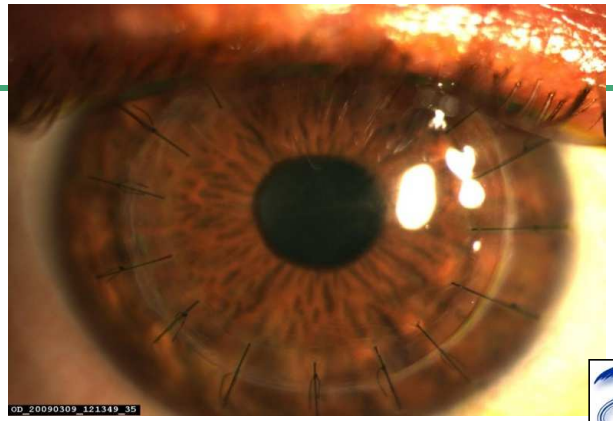
Intolérance
Sutures

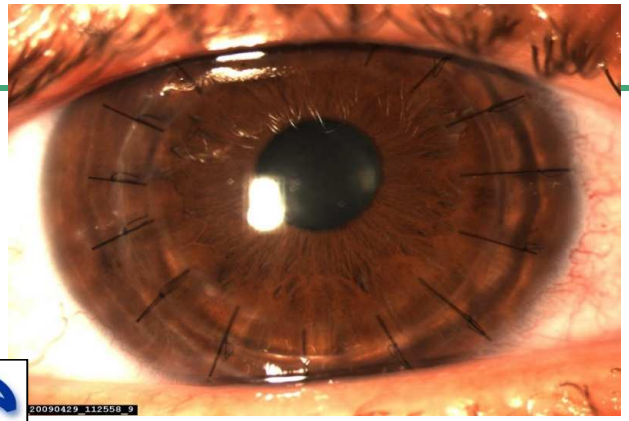
Greffes transfixiantes : Complications

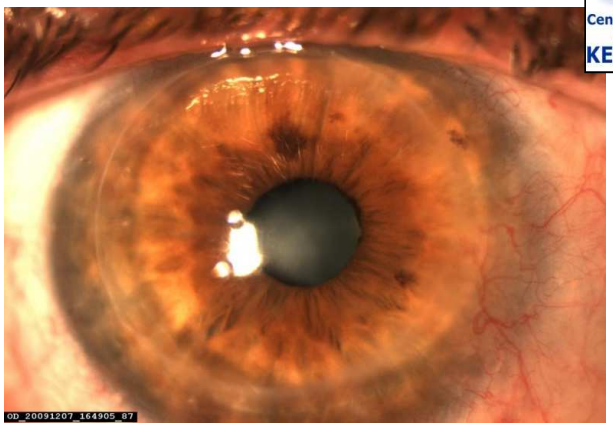


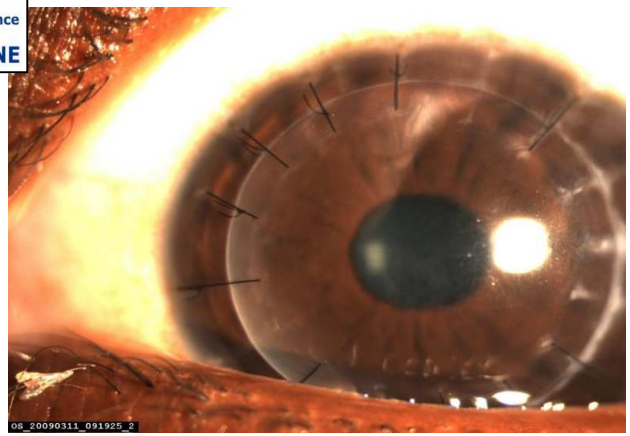
Glaucome secondaire

Greffes Lamellaires antérieures : Moins de Complications





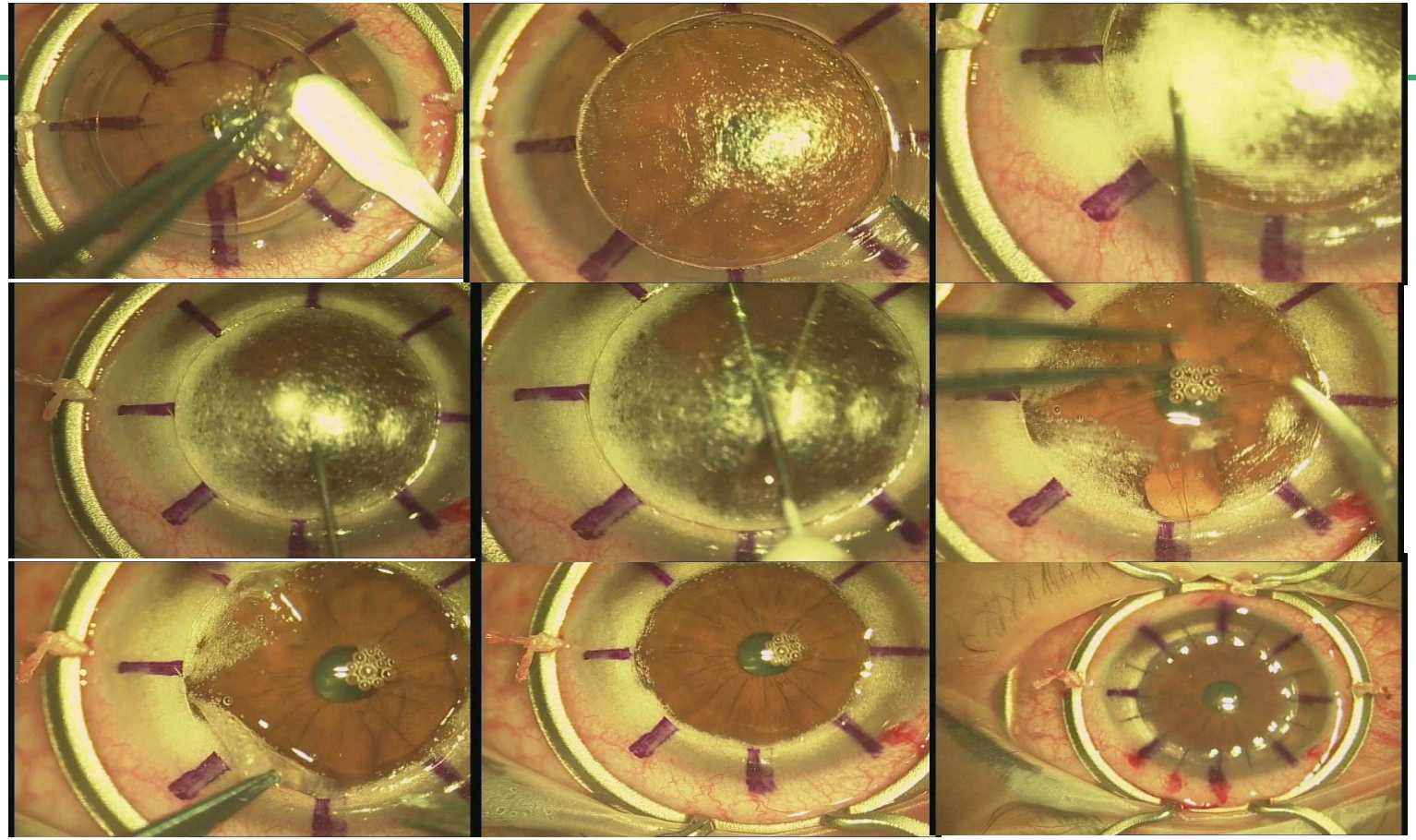




Centre de Référence National du KERATOCONE

KLAP

Mais beaucoup plus technique…



KLAP

KLAP : Récupération plus rapide

ZEISS

Visante™ OCT
ANTERIOR SEGMENT IMAGING

Résultats OCT Visante: De J1 à J 7 !



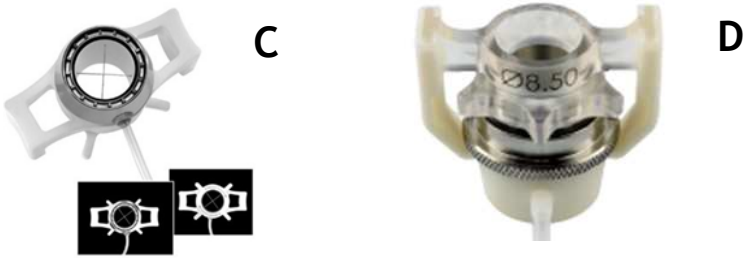
DM POUR KT ET KLAP

- 1er temps : trépanation greffon/punch donneur
  - Punch donneur : Barron, Hanna, Moria (voie post)
  - Trépans sur chambre antérieure artificielle (voie ant)
    - Diamètre 6mm à 9,5mm (pas de 0,25mm à 0,5mm)
- 2nd temps : trépanation cornée receveur
  - Trépan receveur : Barron, Hanna, Castroviejo, Moria
  - Butée réglable pour KLAP (Moria)
    - Diamètre : diamètre 6mm à 9,5mm (pas de 0,25mm à 0,5mm)
- 3ème temps : Suture berges greffon : Nylon 10-0
  - Surjet 360° et/ou 16 points séparés





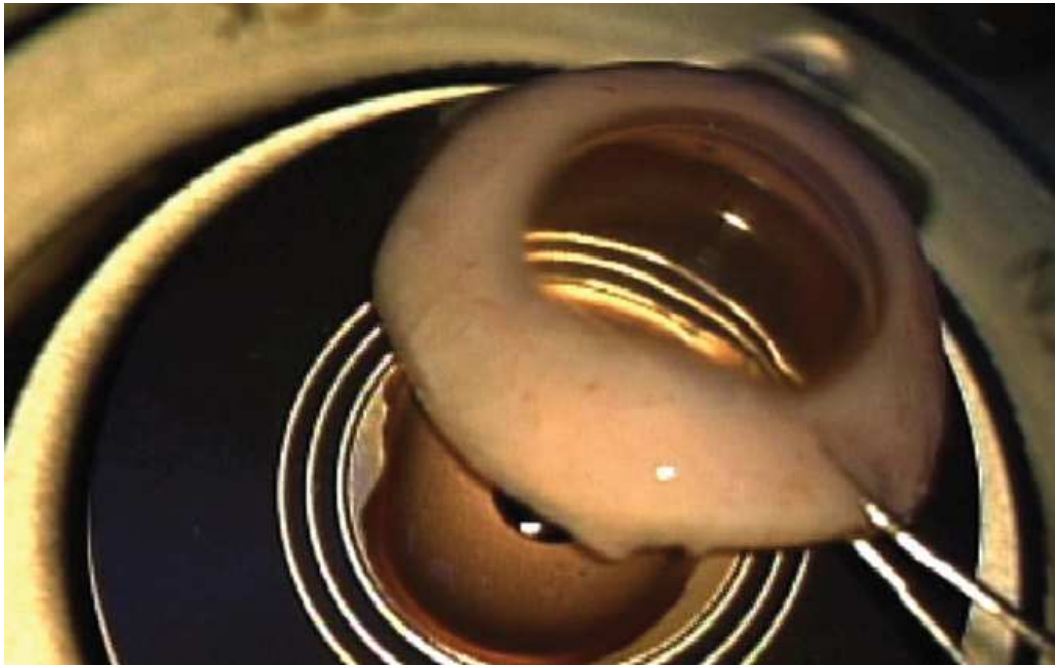
Exemples de Punch donneur à UU
A : Punch de Barron (Ophta) B : Punch (Moria)



Exemples de trépans receveur à UU
C : Trépan de Barron (Ophta) D : Trépan réglable (Moria)

Greffes endothéliales : DSEAK

Usage de la CHAMBRE ANTÉRIEURE ARTIFICIELLE

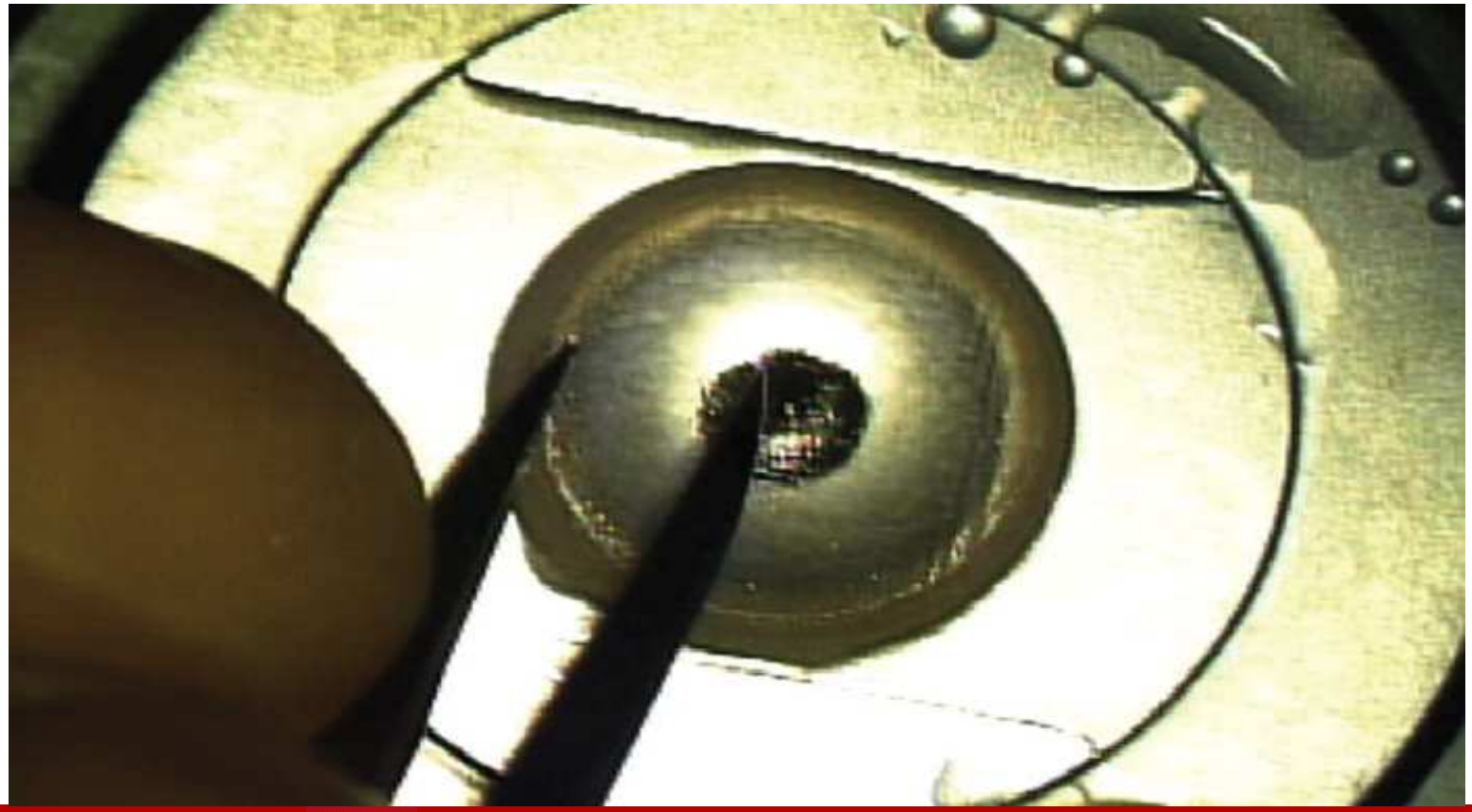




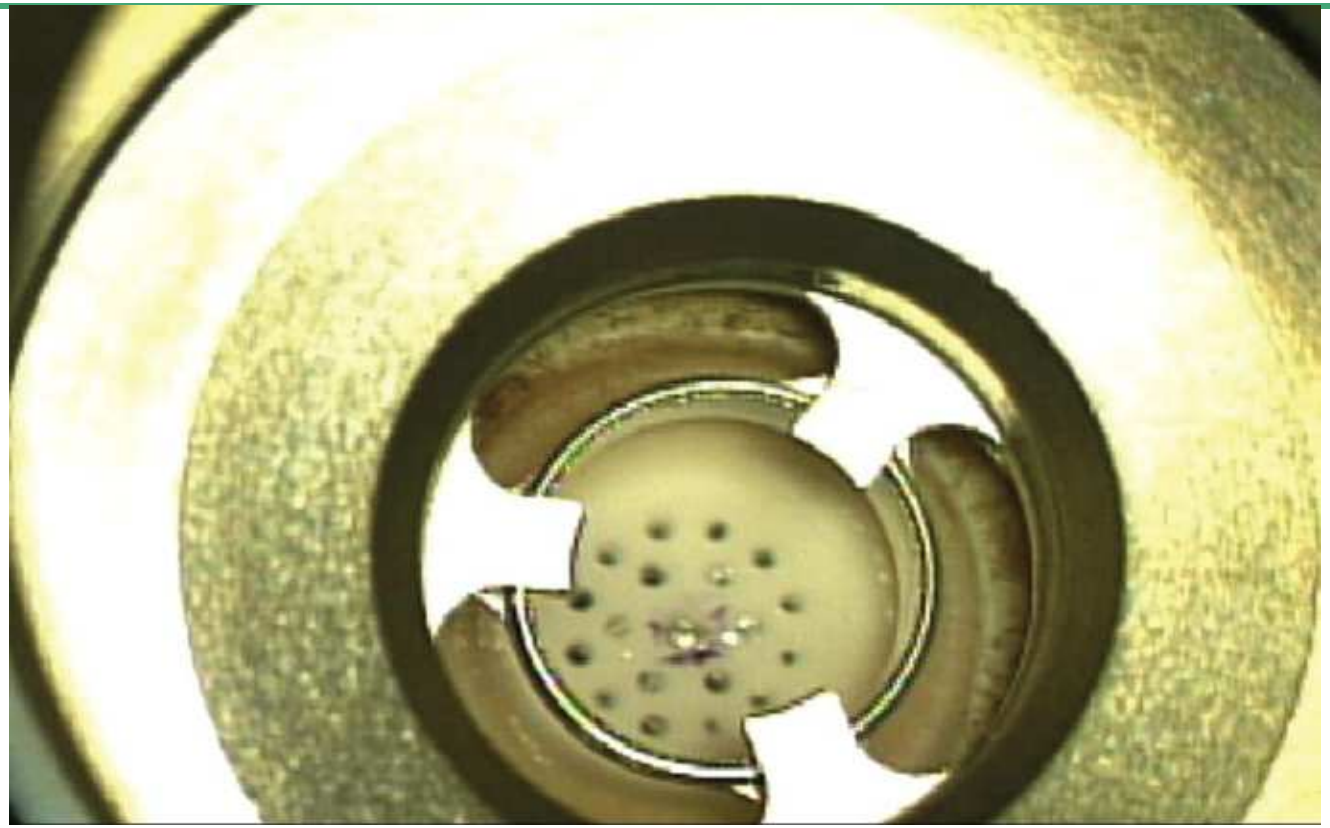
DÉCOUPE Lamelle antérieure
→ Microkératome mécanique



VÉRIFICATION DE LA QUALITÉ DE LA DÉCOUPE

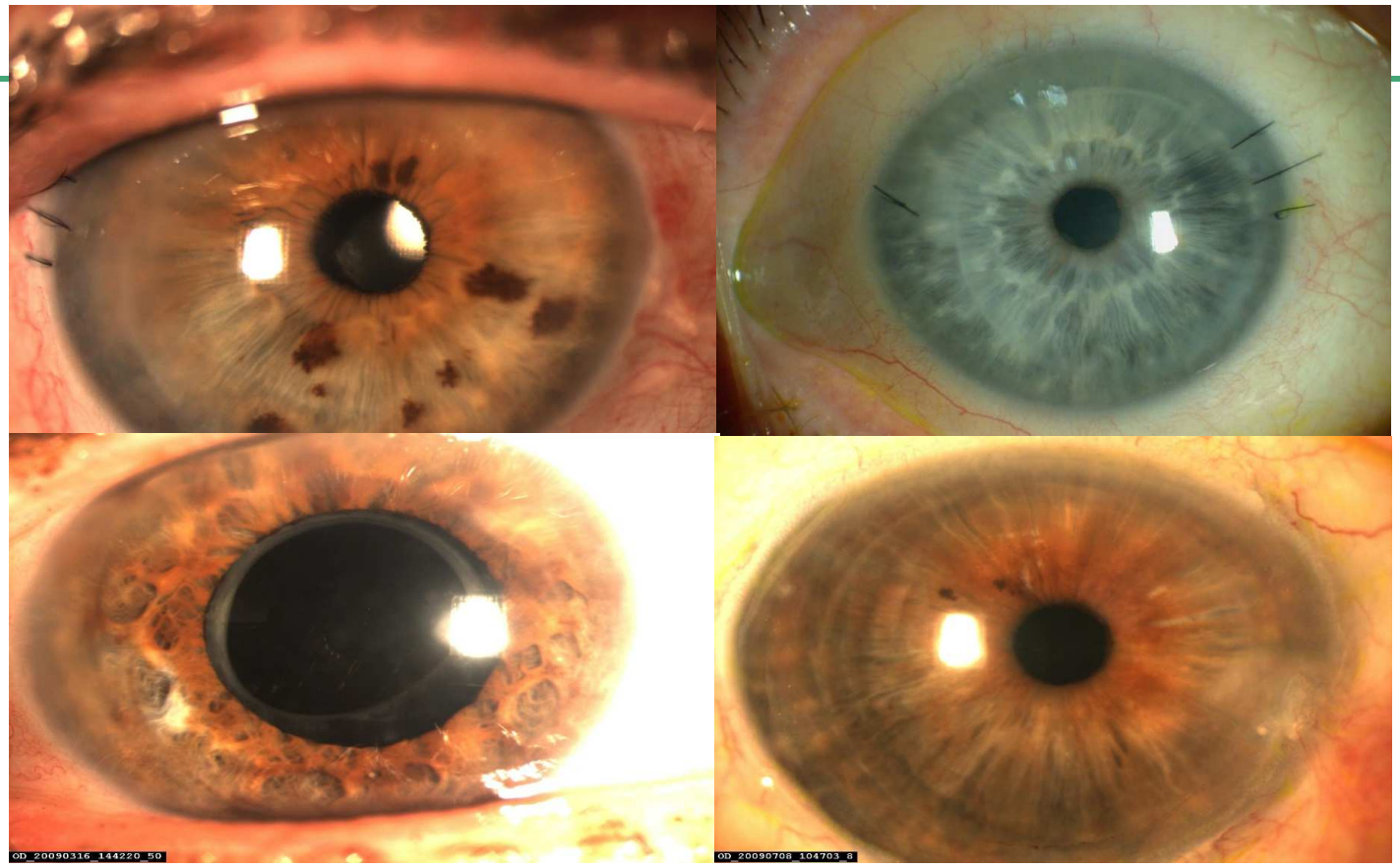


DÉCOUPE DES BERGES
au Punch, par voie postérieure



Lamelle 8 mm
Diamètre
100 à 150 microns
Prète pour
l'insertion en
chambre
antérieure

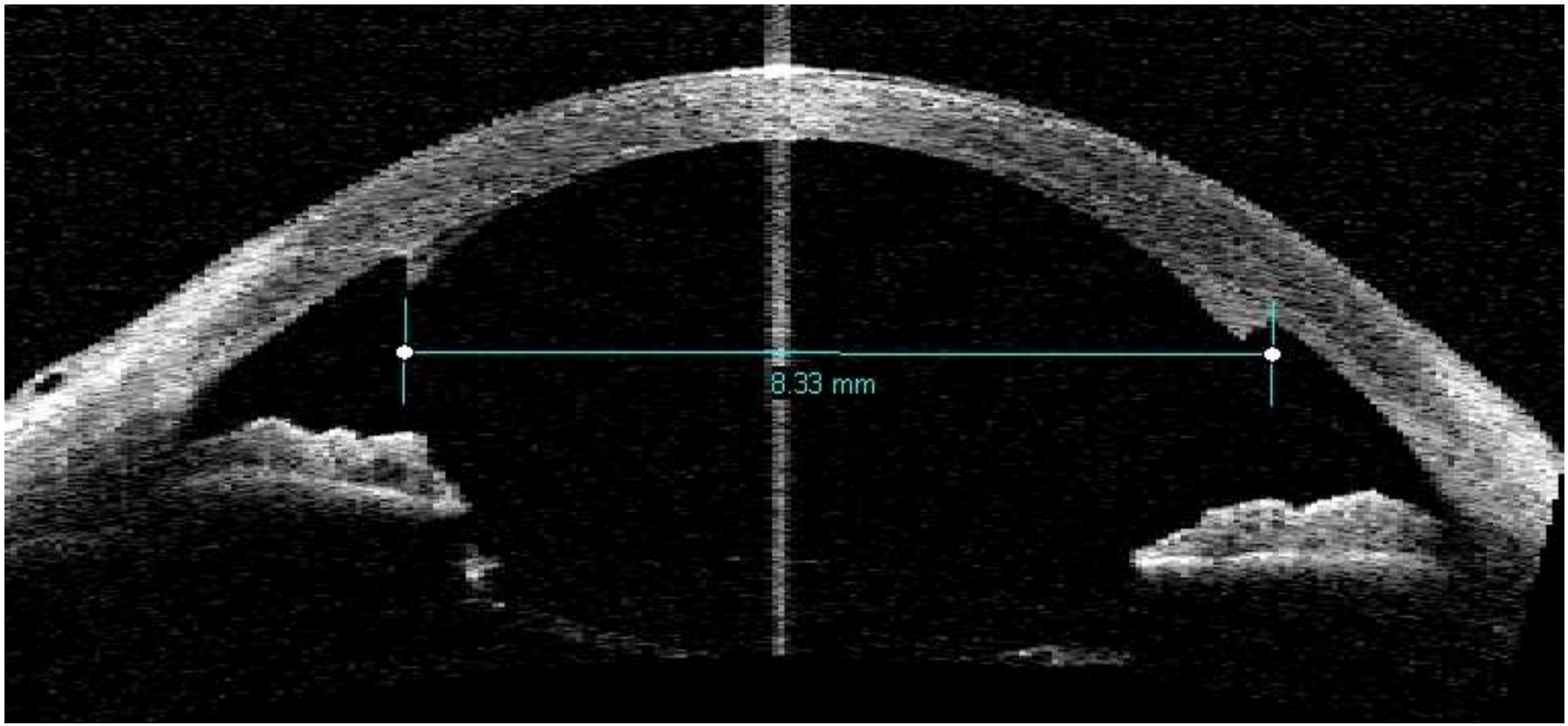
Résultat DSEAK post op



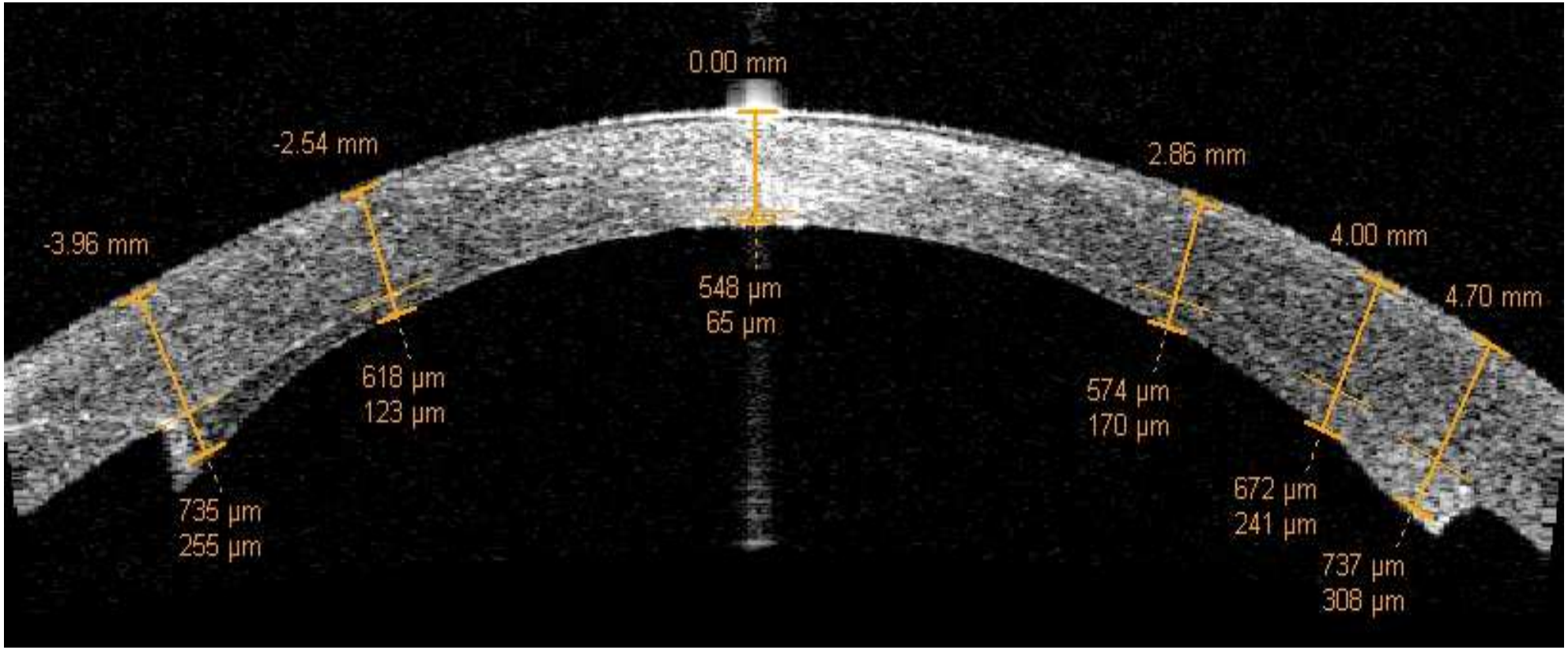
Avantages sur KT

- Anesthesie locale
- Récupération rapide
- Pas de suture
- Conservation cornée patient (sauf endothélium)
- Rejet plus rare
- Globe non fragilisé

DSEAK - OCT J40

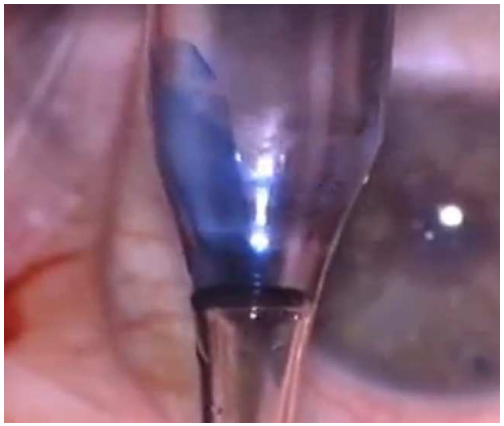


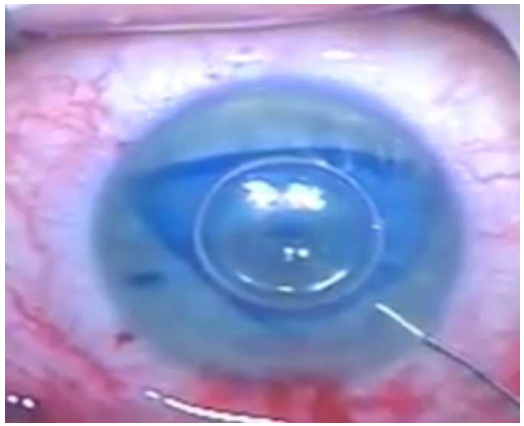
DSEAK - OCT J40 - Zoom



Variation : DMEK (sans microkératome)







DM POUR la DSEAK



- Préparation du greffon avec microkératome mécanique
  - Chambre antérieure artificielle (usage unique +/-)
  - Console
  - Tubulures
  - Turbine
  - Lames



Stérilisable

Usage unique





Turbine









Tête à usage unique

Têtes réutilisables ou à usage unique

ÉVOLUTIONS
→ Automatisation de la vitesse de coupe

- Système automatique (Console Moria spécifique)





Pièce à main



Tête à usage unique

DM POUR DSEAK : Aide insertion greffon

- Matériel spécifique pour injection greffon endothélial
  - Spatules et pinces
  - Injecteurs (Endosaver®)



Spatule et Pince de Busin



Endosaver® : injecteur à UU

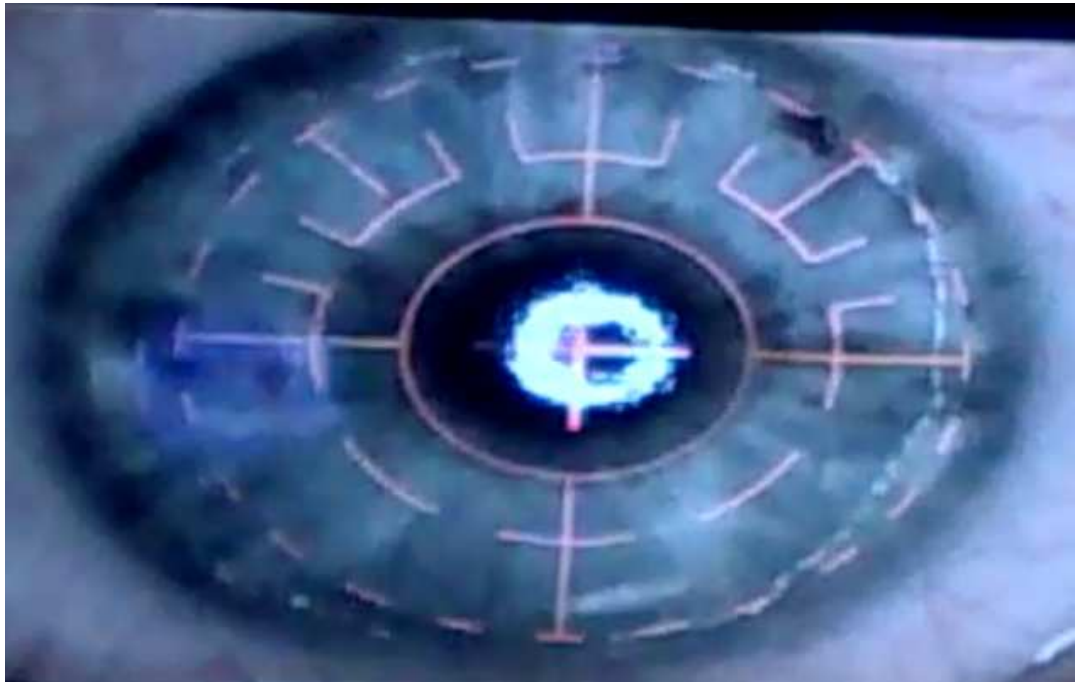
CHIRURGIE RÉFRACTIVE LASER





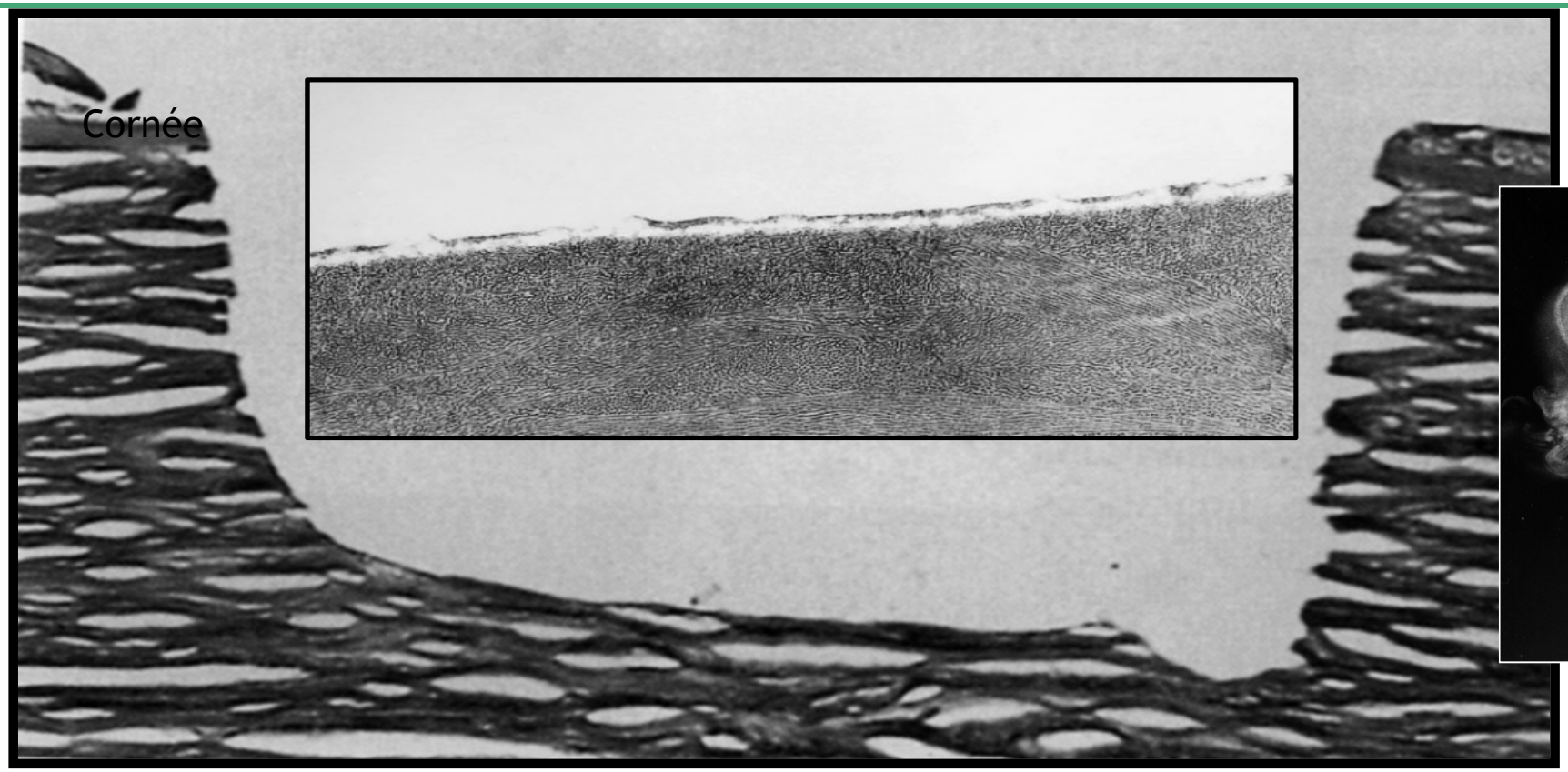
CHIRURGIE RÉFRACTIVE
LASER EXCIMER DE SURFACE : PKR/PKT

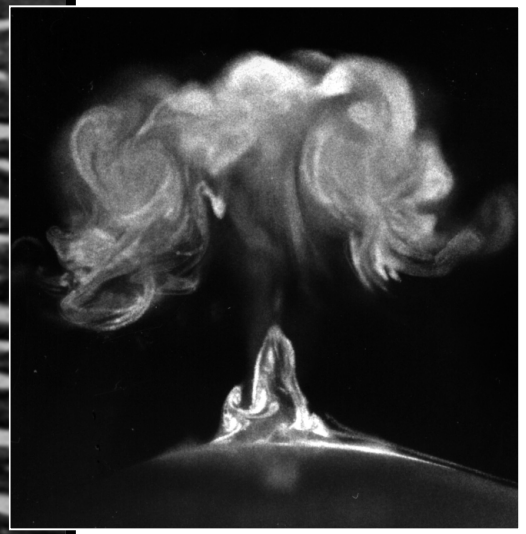




MECANISME PHOTOABLATIF

Laser EXCIMER 193 nm





USA
Visx
Japon
Nidek

Lasers Excimers
Principaux acteurs

Allemagne
Wavelight
Bausch/Lomb
Schwind
Zeiss

NIDEK - (EC-5000 CX III) Myopia, Hyperopia and Astigmatism



50 Hz

Carl Zeiss Meditec - (MEL 80 EXCIMER Laser) not approved to treat hyperopia



10-250 Hz

Baush and Lomb - (Zyoptix Custom)



50-100 Hz

Abbott Medical Optics - Visx (STAR S4 IR EXCIMER Laser) Custom



10-50 Hz

Alcon - WaveLight® EX500 Excimer Laser



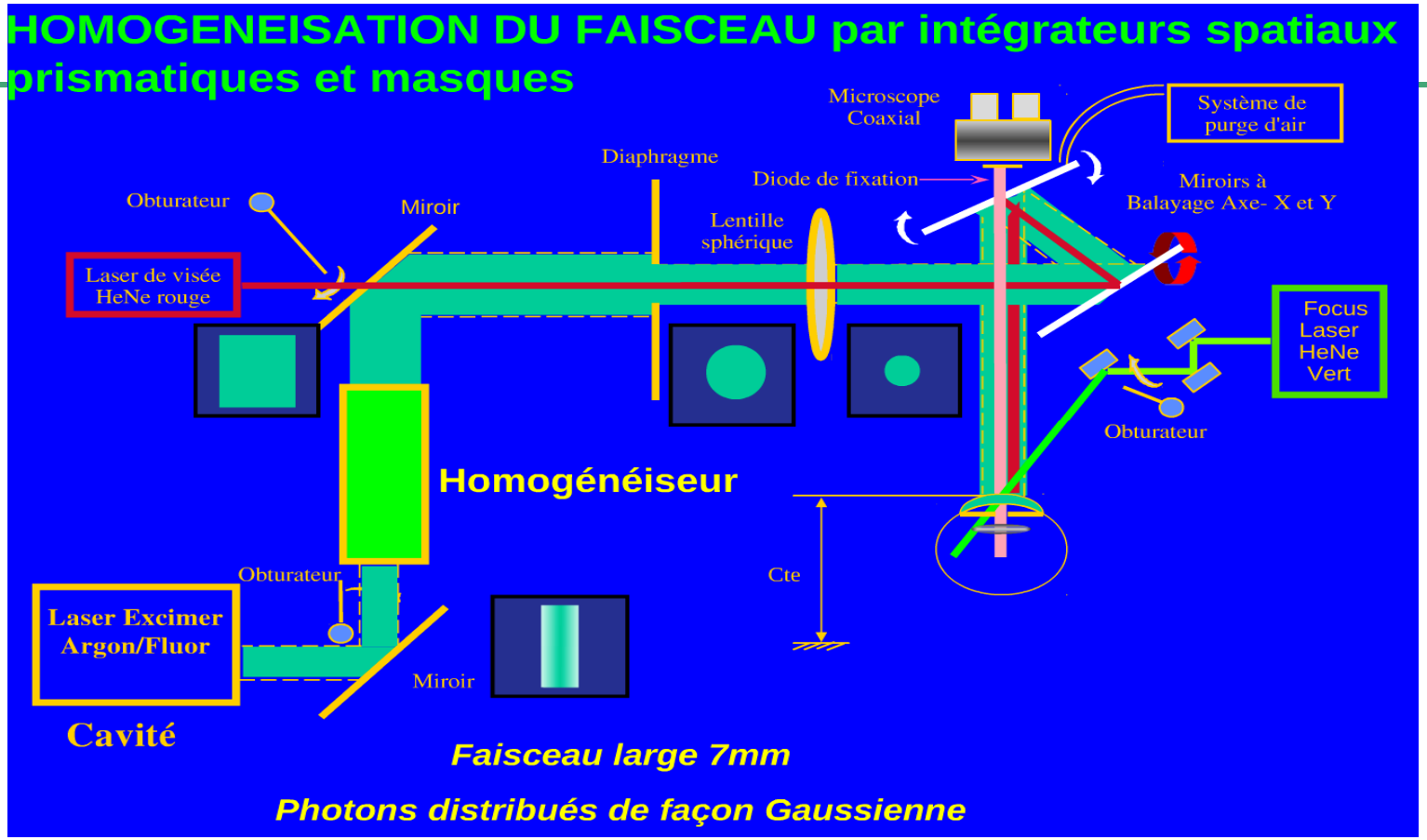
500 Hz

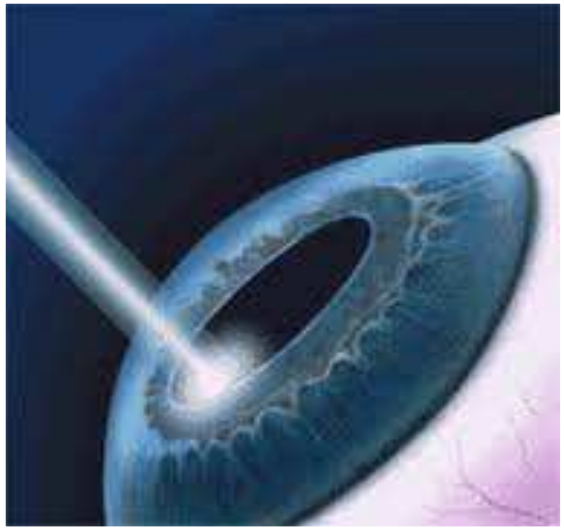
ALLEGRETTO 200 and 400 Hz WAVE EYE-Q EXCIMER Laser



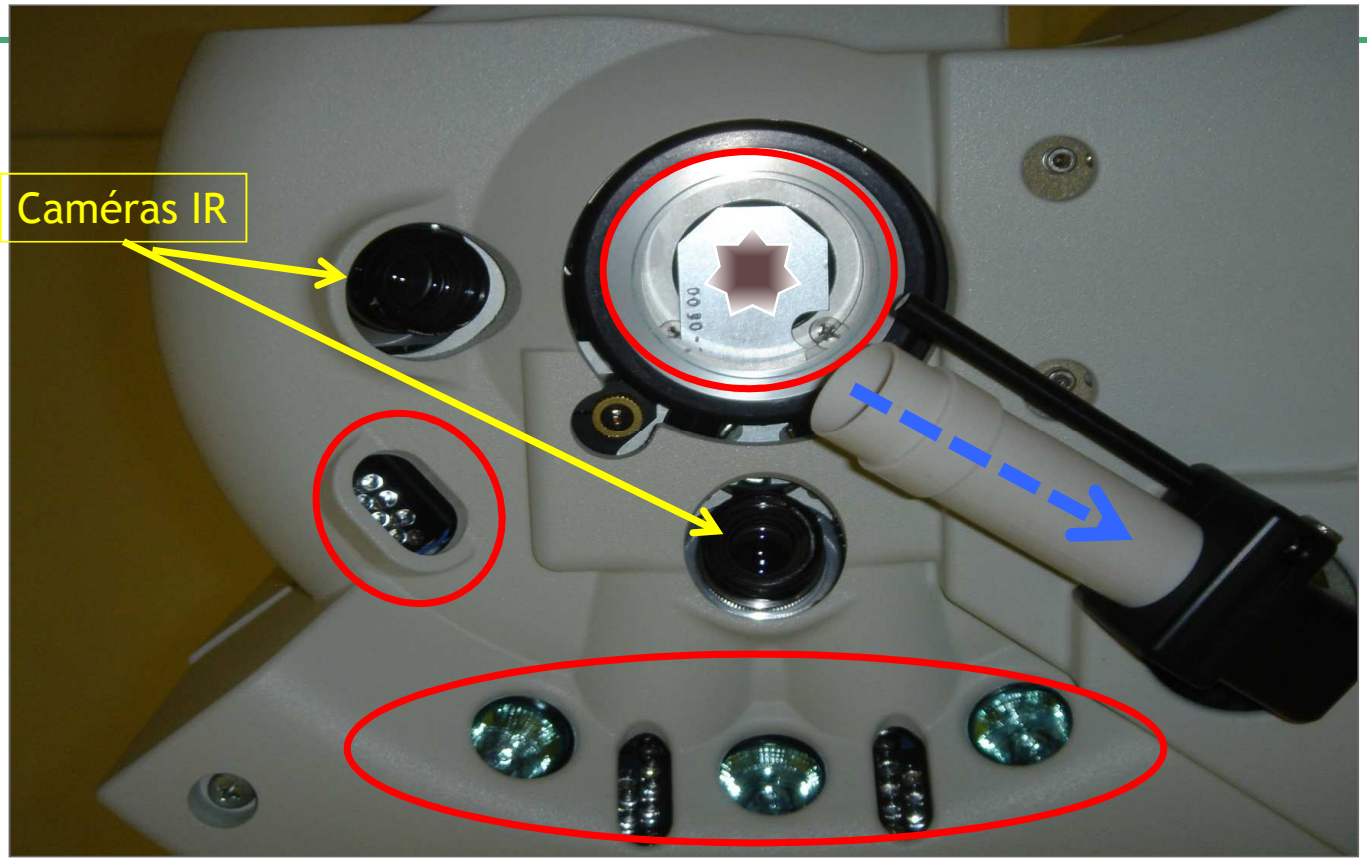
400 Hz

UN TRAJET OPTIQUE COMPLEXE

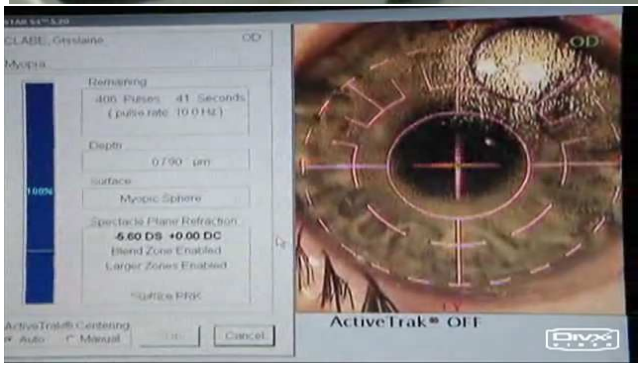


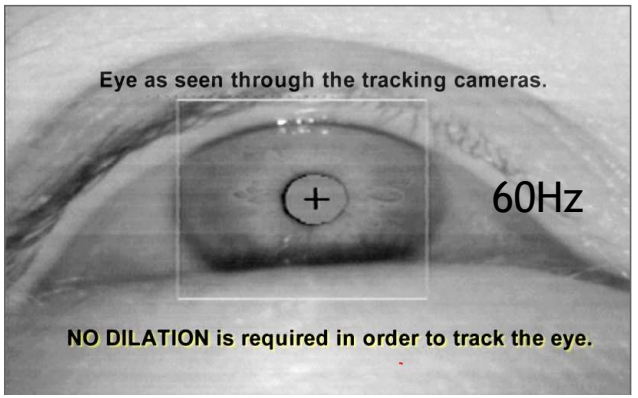


CE QUE VOIT LE PATIENT ?



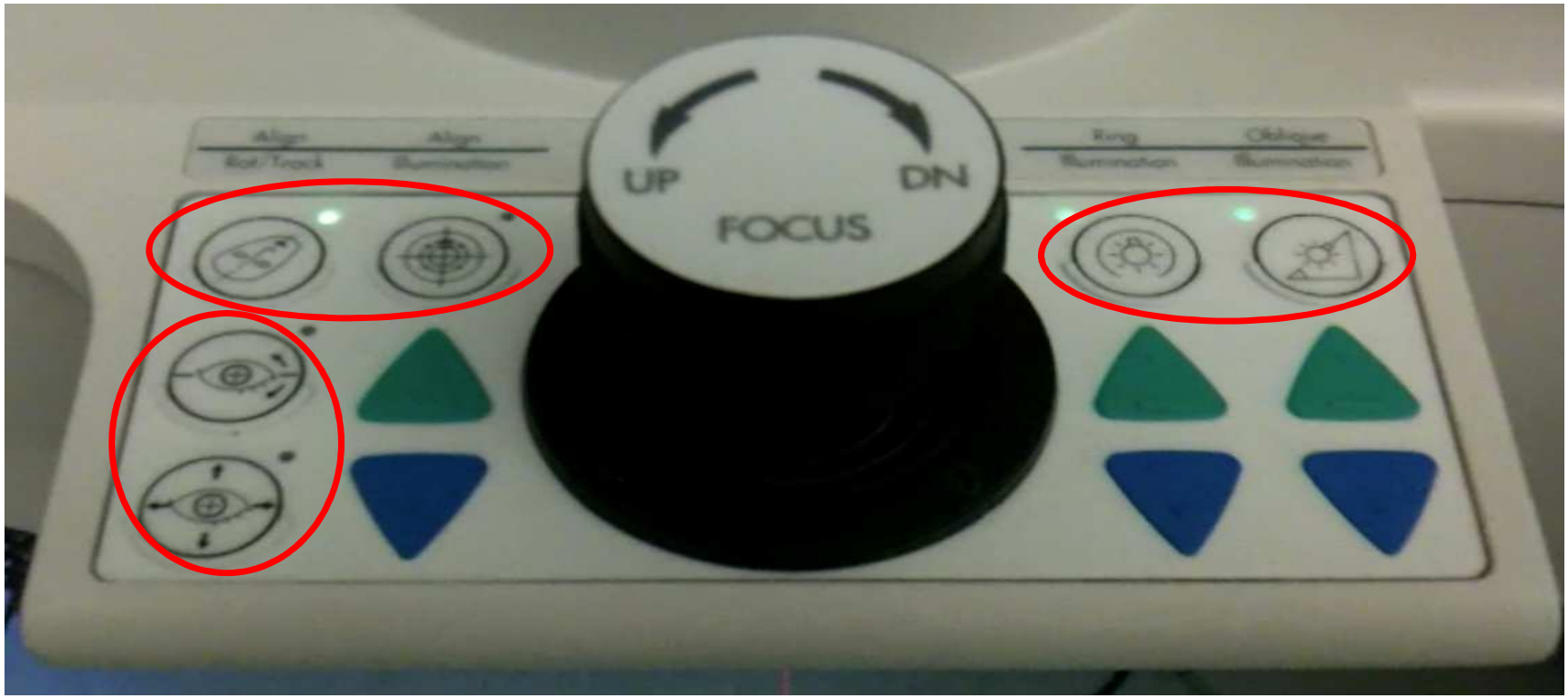




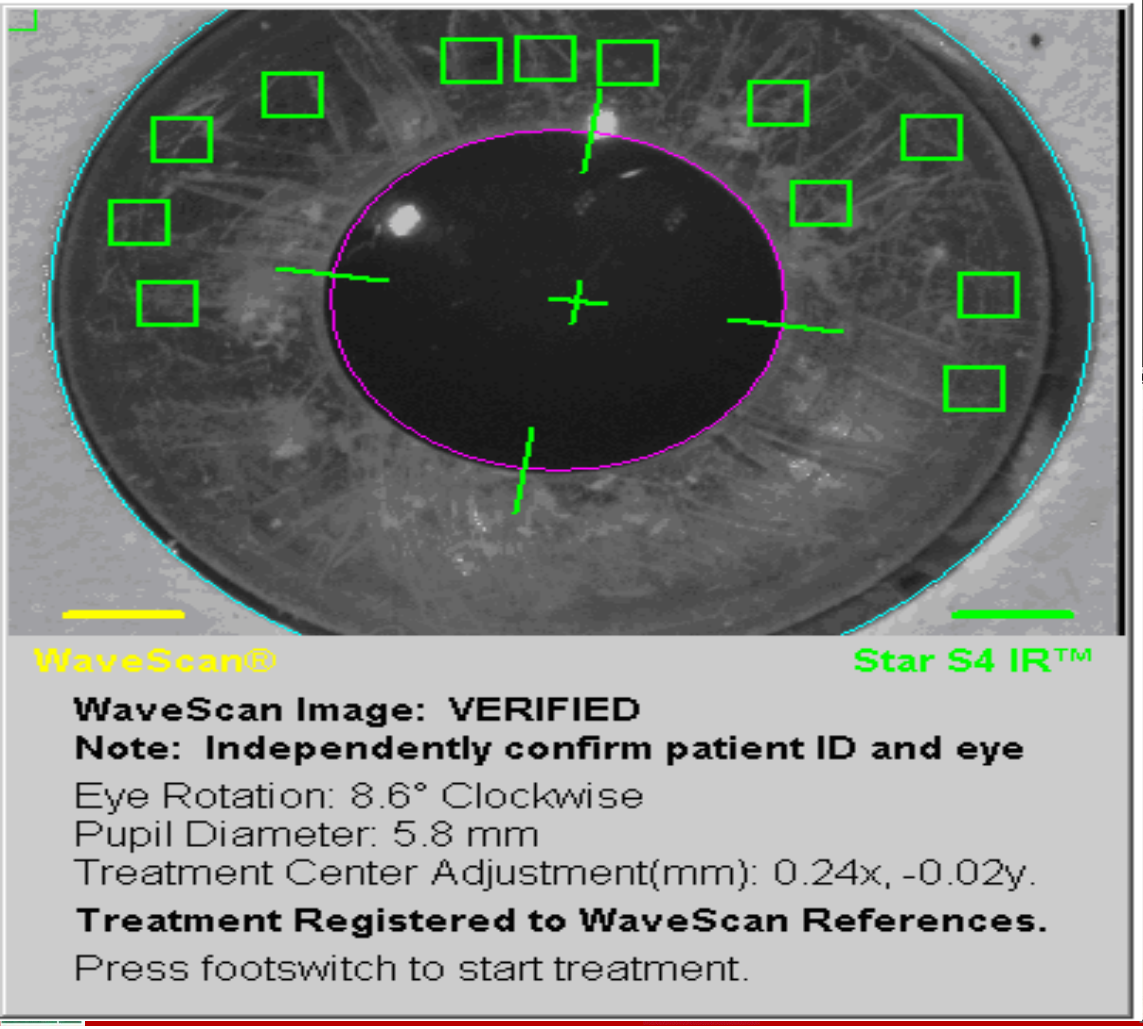


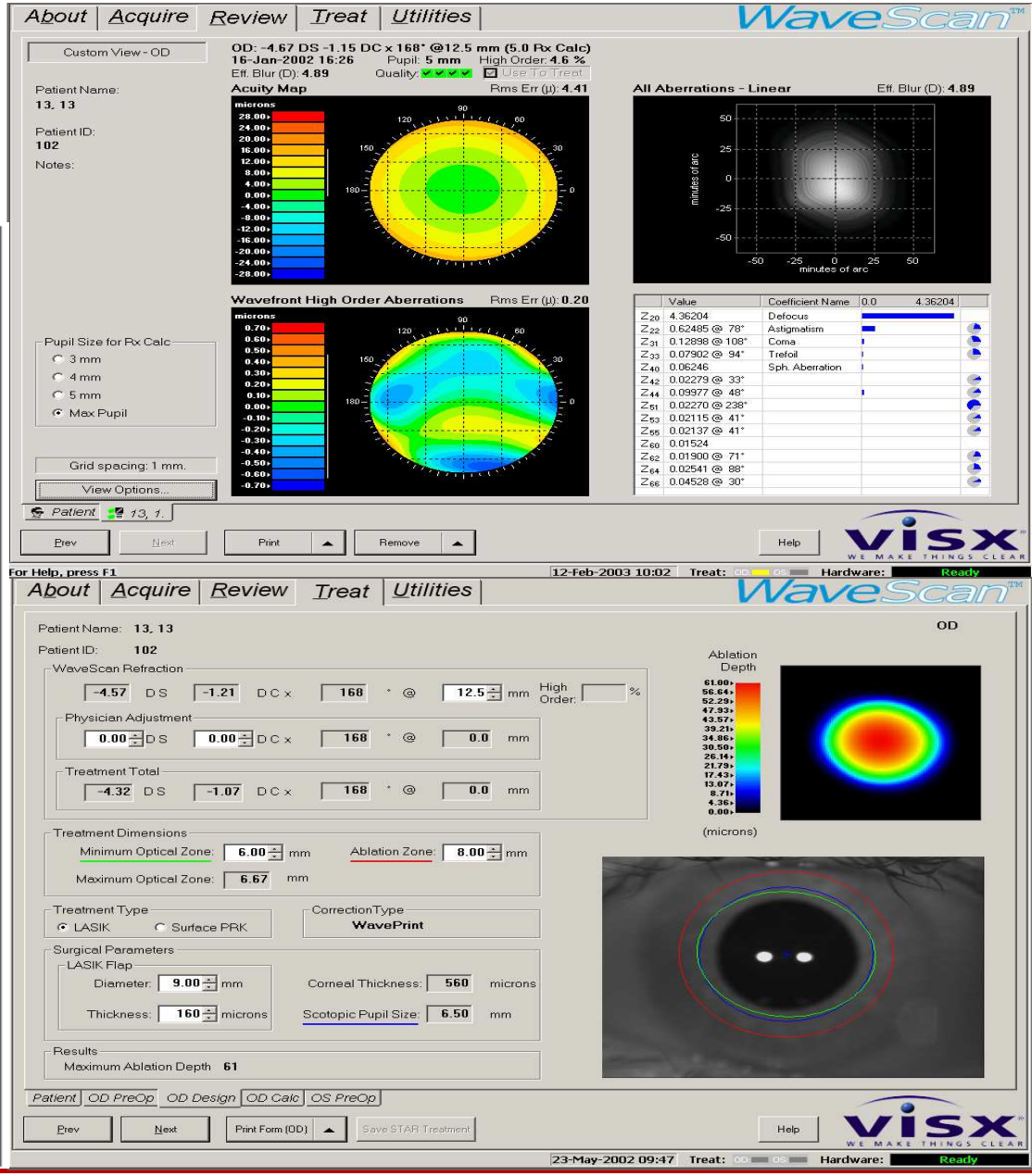
Tracker - 3x plus rapide que la fréquence de tir

INTERFACE DE CONTRÔLE



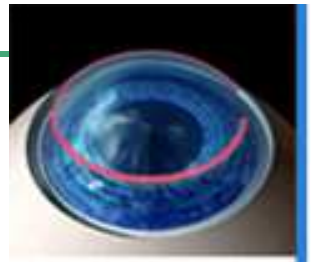
EYE TRACKER


WaveScan®
Star S4 IR™
WaveScan Image: VERIFIED
Note: Independently confirm patient ID and eye
Eye Rotation: 8.6° Clockwise
Pupil Diameter: 5.8 mm
Treatment Center Adjustment(mm): 0.24x, -0.02y.
Treatment Registered to WaveScan References.
Press footswitch to start treatment.

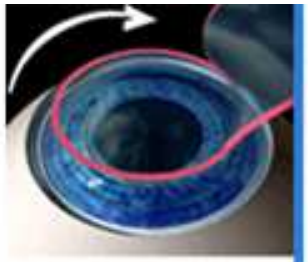

About | Acquire | Review | Treat | Utilities
WaveScan
Custom View - OD
OD: -4.67 DS -1.15 DC x 168° @12.5 mm (5.0 Rx Calc)
16-Jan-2002 16:26 Pupil: 5 mm High Order: 4.6 %
Eff. Blur (D): 4.89 Quality: Use To Treat
Patient Name: 13, 13
Patient ID: 102
Notes:
Acuity Map Rms Err (µ): 4.41
All Aberrations - Linear Eff. Blur (D): 4.89
Wavefront High Order Aberrations Rms Err (µ): 0.20
Pupil Size for Rx Calc
3 mm
4 mm
5 mm
Max Pupil
Grid spacing: 1 mm.
View Options...
Patient 13, 1.
Prev Next Print Remove Help
visx
For Help, press F1
12-Feb-2003 10:02
Treat:
Hardware: Ready
About | Acquire | Review | Treat | Utilities
WaveScan
Patient Name: 13, 13
Patient ID: 102
OD
WaveScan Refraction
-4.57 DS -1.21 DC x 168 ° @ 12.5 mm High Order: %
Physician Adjustment
0.00 DS 0.00 DC x 168 ° @ 0.0 mm
Treatment Total
-4.32 DS -1.07 DC x 168 ° @ 0.0 mm
Ablation Depth
(microns)
Treatment Dimensions
Minimum Optical Zone: 6.00 mm
Ablation Zone: 8.00 mm
Maximum Optical Zone: 6.67 mm
Treatment Type
LASIK Surface PRK
CorrectionType
WavePrint
Surgical Parameters
LASIK Flap
Diameter: 9.00 mm
Thickness: 160 microns
Corneal Thickness: 560 microns
Scotopic Pupil Size: 6.50 mm
Results
Maximum Ablation Depth 61
Patient OD PreOp OD Design OD Calc OS PreOp
Prev Next Print Form (OD) Save STAR Treatment Help
visx
23-May-2002 09:47
Treat:
Hardware: Ready

LASIK assisté par Microkératome Mécanique

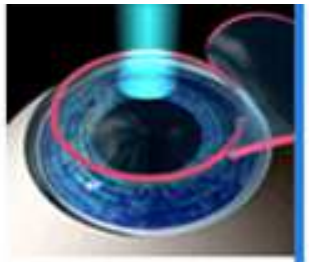
Années 1990



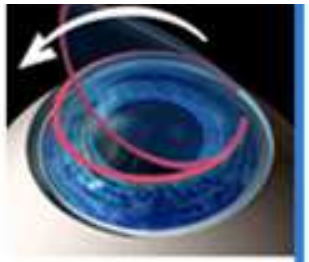
1ère étape : Création d'un volet cornéen



Soulèvement du volet



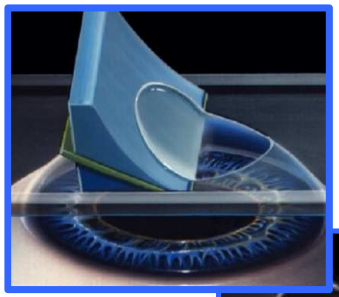
2ème étape : Remodelage de la cornée

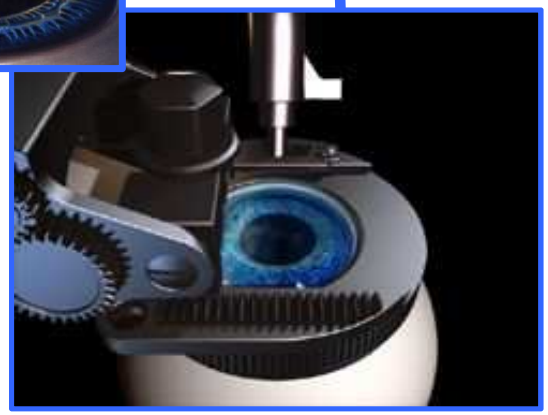


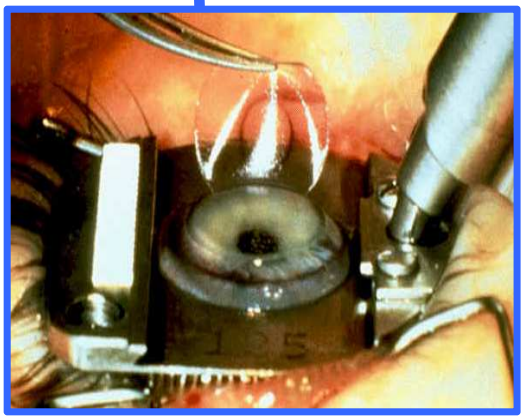
Repositionnement du volet



Oeil corrigé



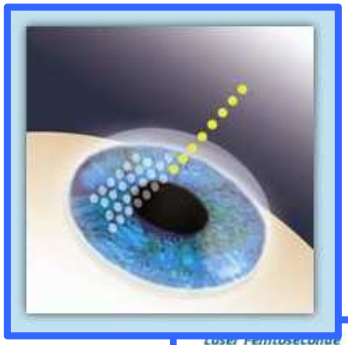






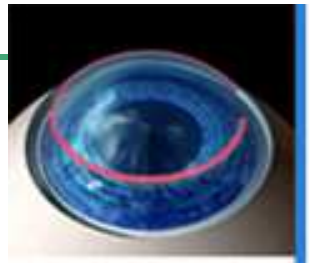
LASIK assisté par Laser FEMTOSECONDE

> Années 2000

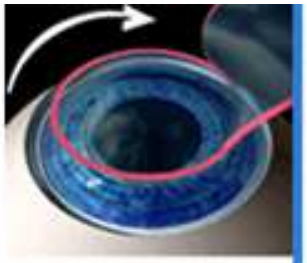




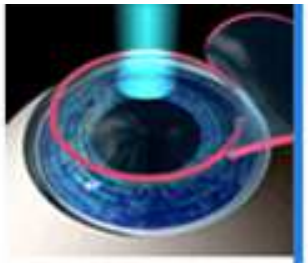




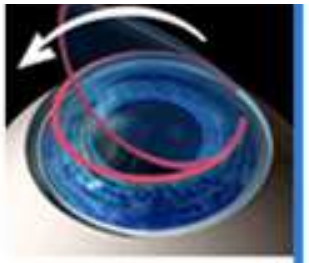
1ère étape :
Création d'un volet cornéen



Soulèvement du volet



2ème étape :
Remodelage de la cornée



Repositionnement du volet



Oeil corrigé





Lasers femtoseconde pour la cornée



Intralase
Abbott



Femto
LDV
Ziemer



FEMTEC ®
Technolas
Perfect Vision

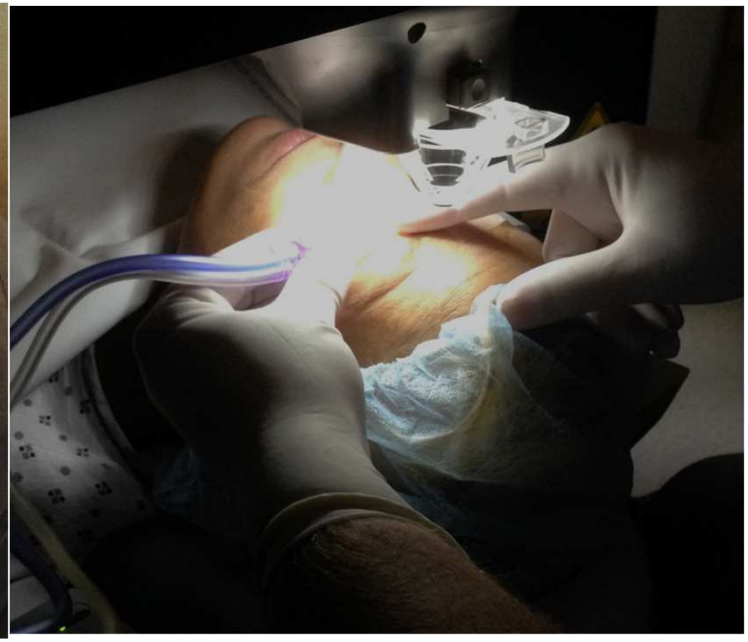


Visumax
Zeiss

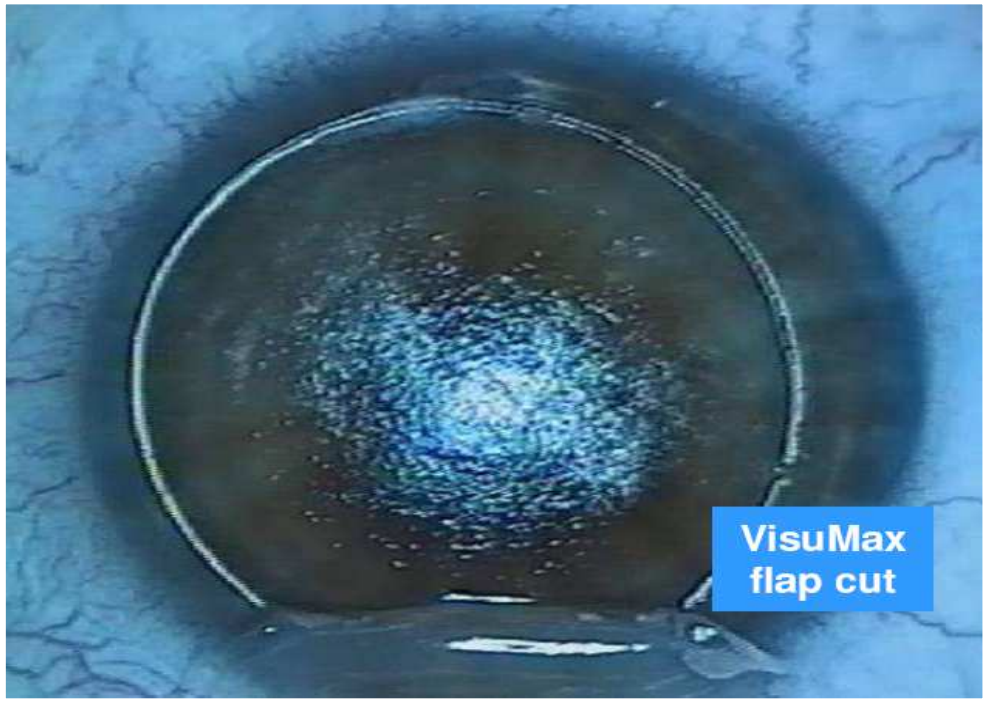


Wavelight
Alcon

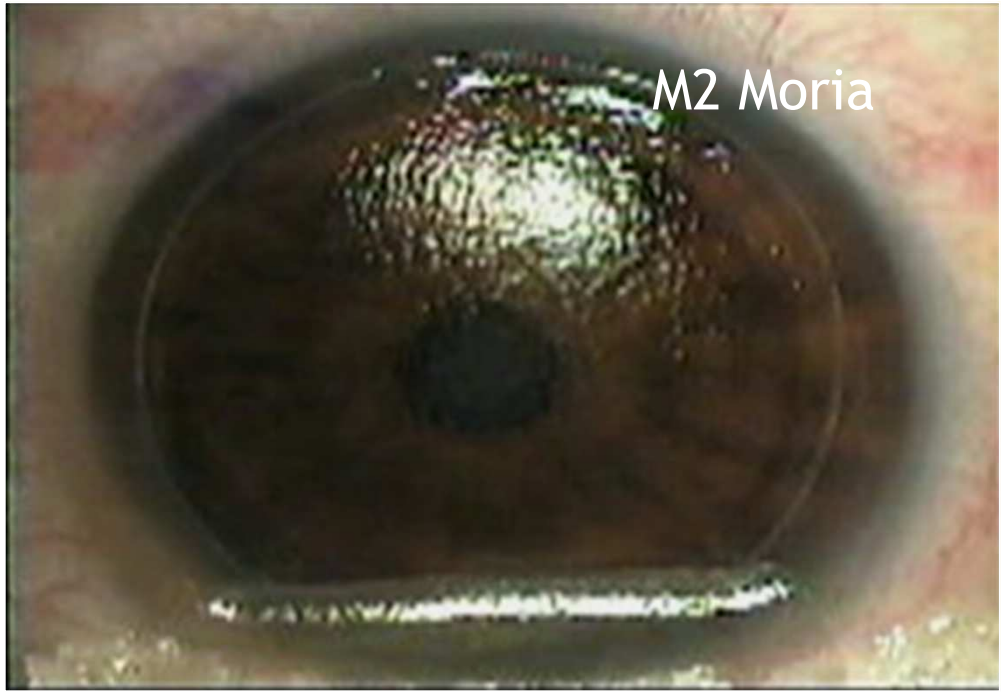




LASIK: Laser versus Lame



VS

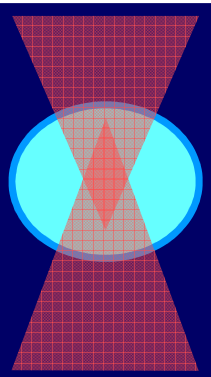


Laser

Lame

Interaction Tissulaire Laser femtoseconde

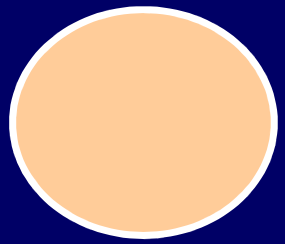
Ablation Induite par plasma



CORNEE

IONISATION

Cavitation



Onde de choc

Micro bulles COLLAPSUS



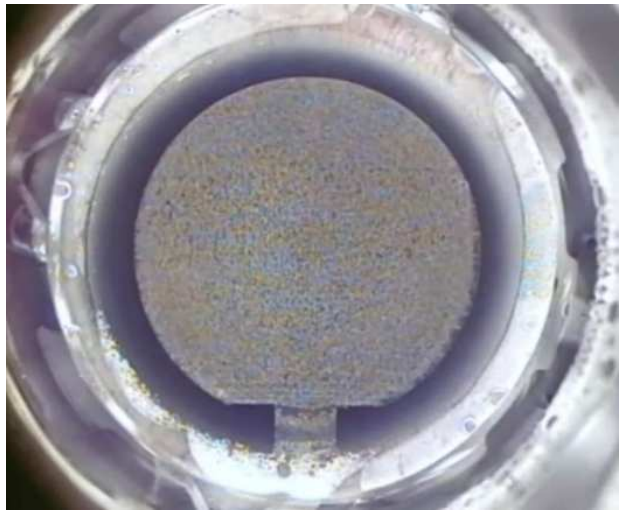
Défect Tissulaire

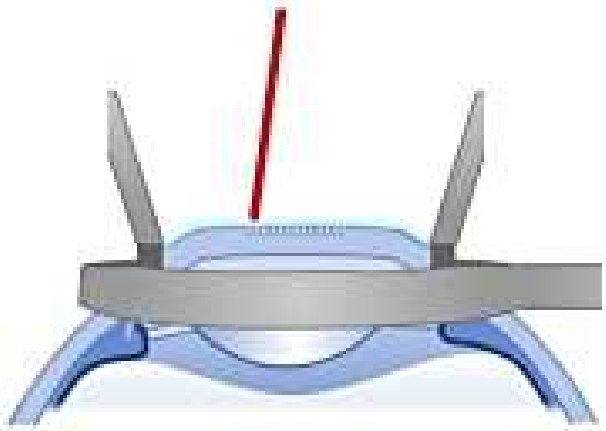
Dr D. Touboul

→ INTERET CHIRURGICAL ←

Méthode de découpe en TIMBRE POSTE





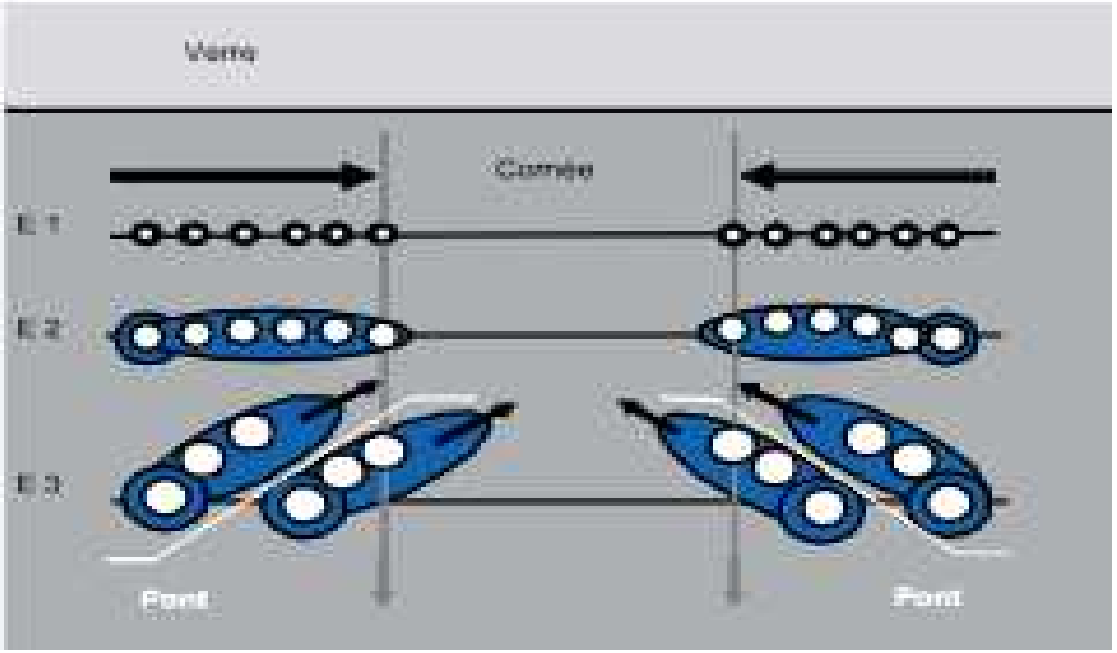


La Maîtrise de la
FORME et de la POSITION des DEFAUTS
Permet une Découpe en Profondeur SANS Ouverture en Surface

Convivialité du femtoLASIK

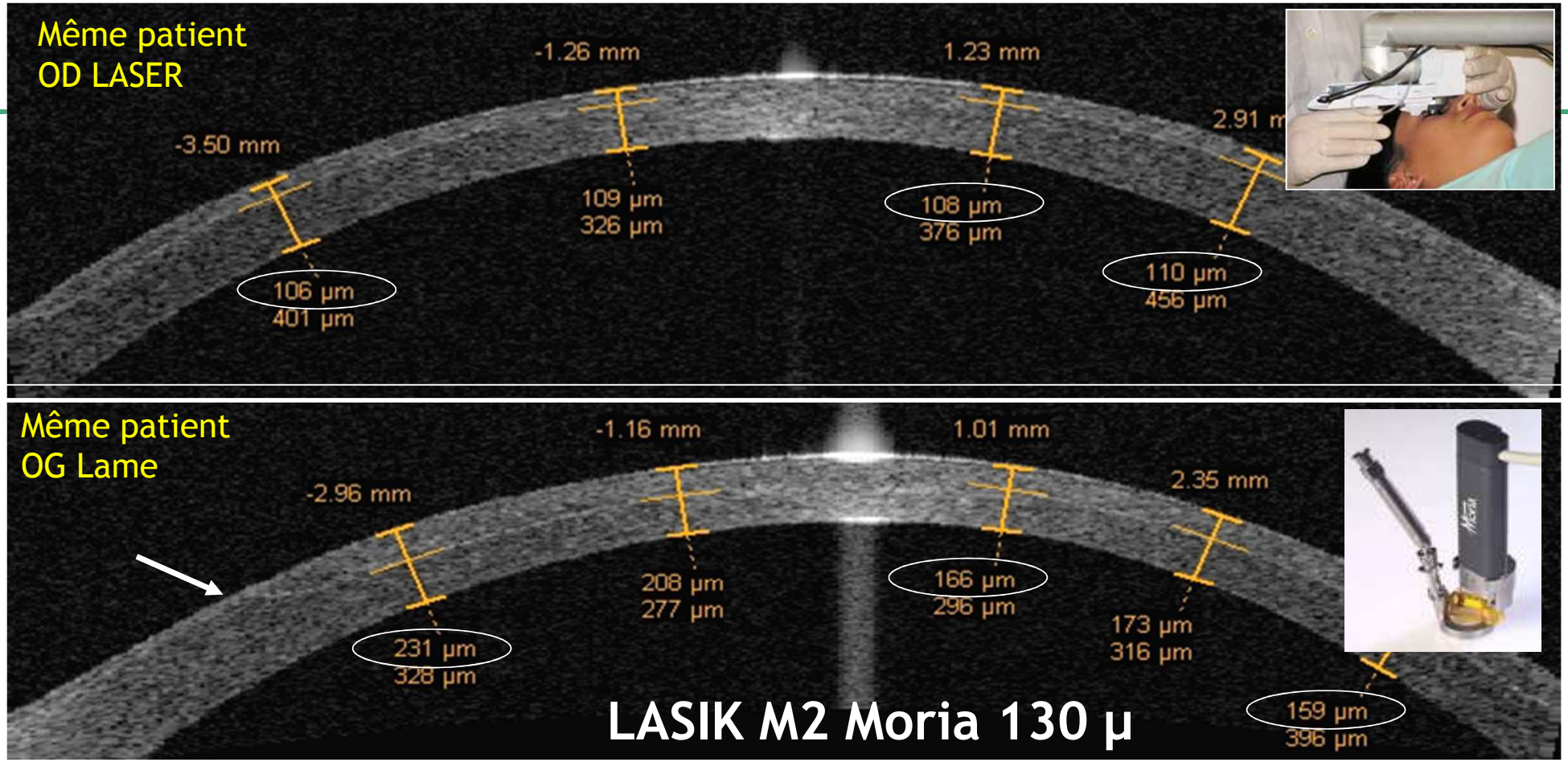


« AÉRO-DISSECTION » LASER INDUITE



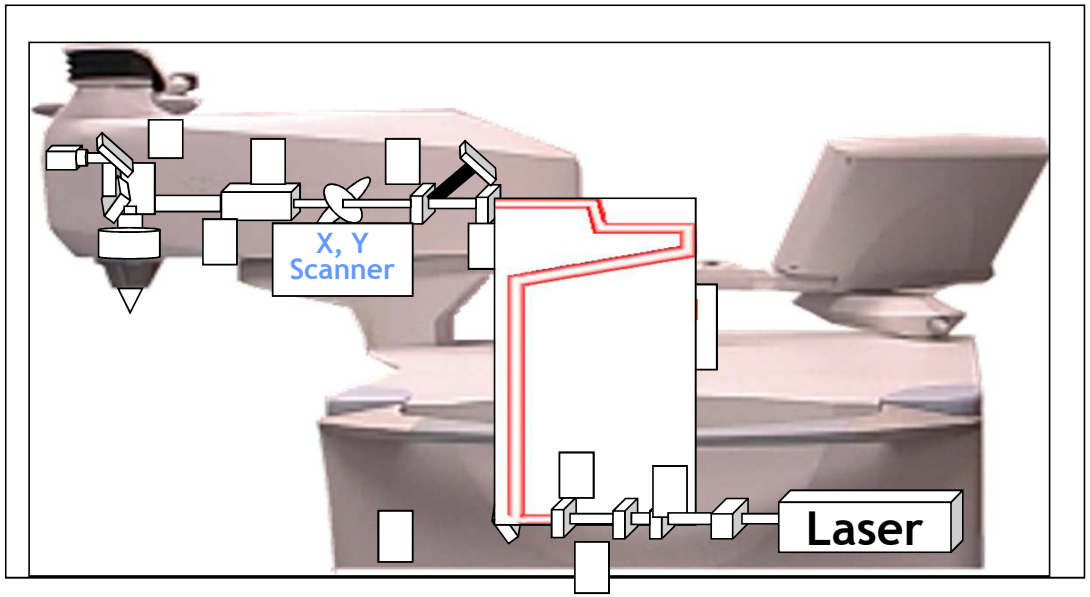


VOLET LASIK


Même patient
OD LASER
-1.26 mm
1.23 mm
-3.50 mm
109 µm
326 µm
108 µm
376 µm
106 µm
401 µm
110 µm
456 µm
Même patient
OG Lame
-1.16 mm
1.01 mm
-2.96 mm
2.35 mm
208 µm
277 µm
166 µm
296 µm
231 µm
328 µm
173 µm
316 µm
159 µm
396 µm
LASIK M2 Moria 130 µ

3 éléments sont importants pour distinguer les différents lasers fs

- Nature de la source fs
- Système optique
- L'interface oeil/machine



Systèmes d'interfaces d'Aplanation lasers fs

Aplanation Plano



Intralase/ IFS Abbott
FS200 - Alcon Wavelight



Ziemer
Femto LDV ®

Aplanation Courbe



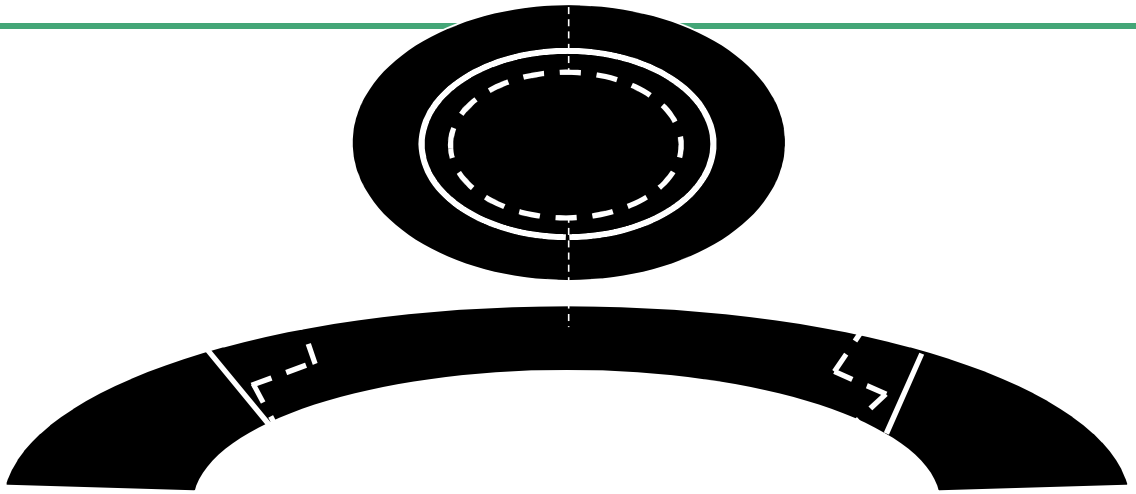
Baush&Lomb
Victus ®

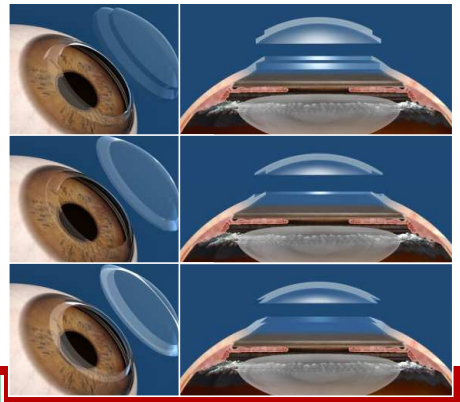


Zeiss
Visumax ®

Greffes assistées par lasers fs ?

Modulation Transverse

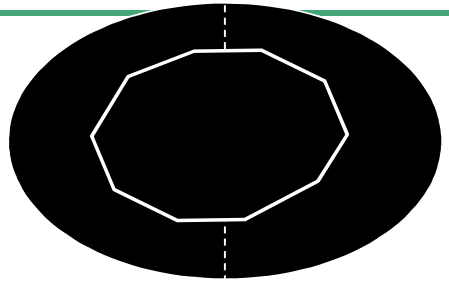


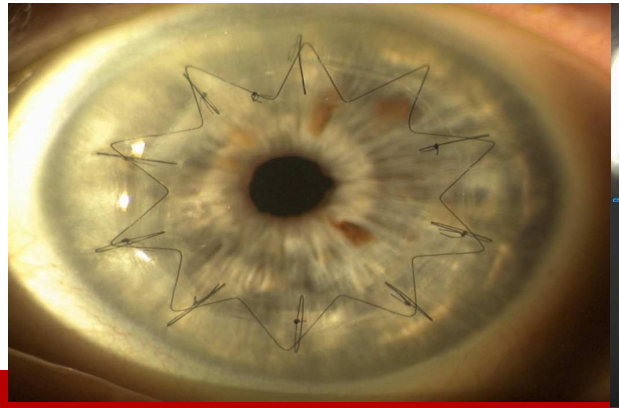




AMO - D Rootman

Modulation Sagittale

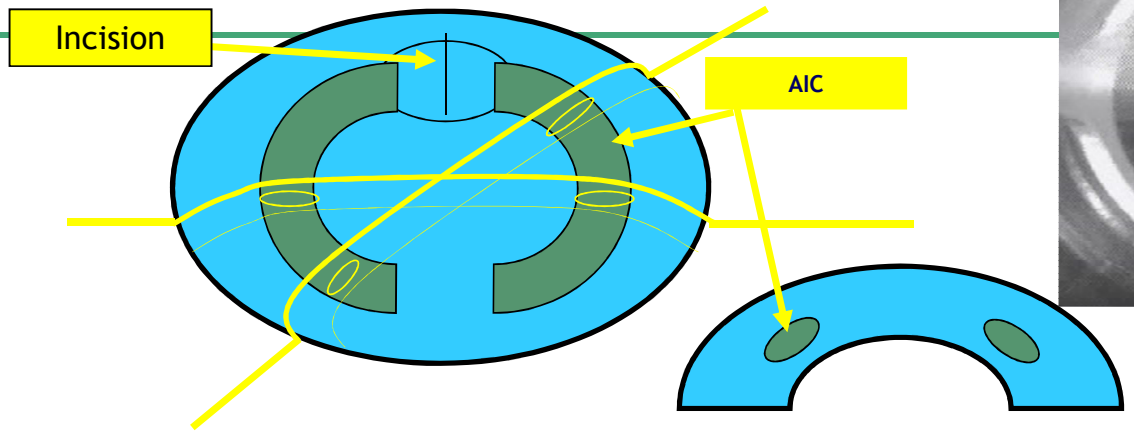


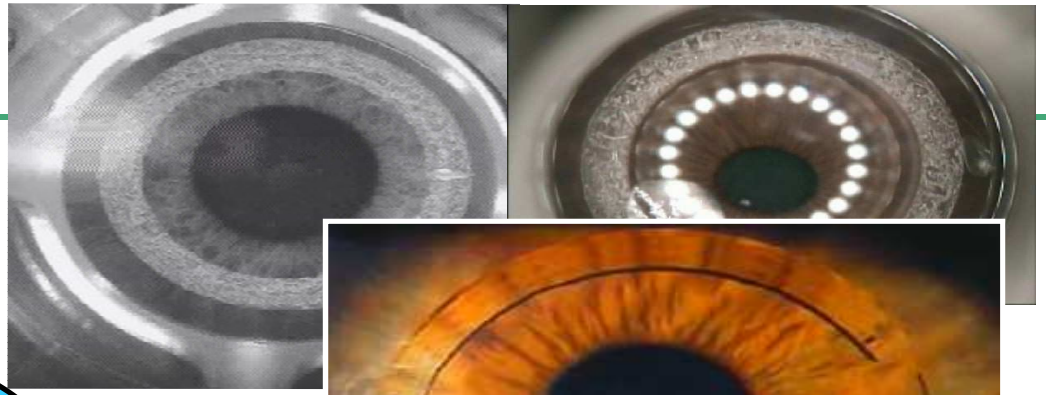




FEMTEC - H. Proust

Anneaux Intra-Cornéens +++ Gold standard

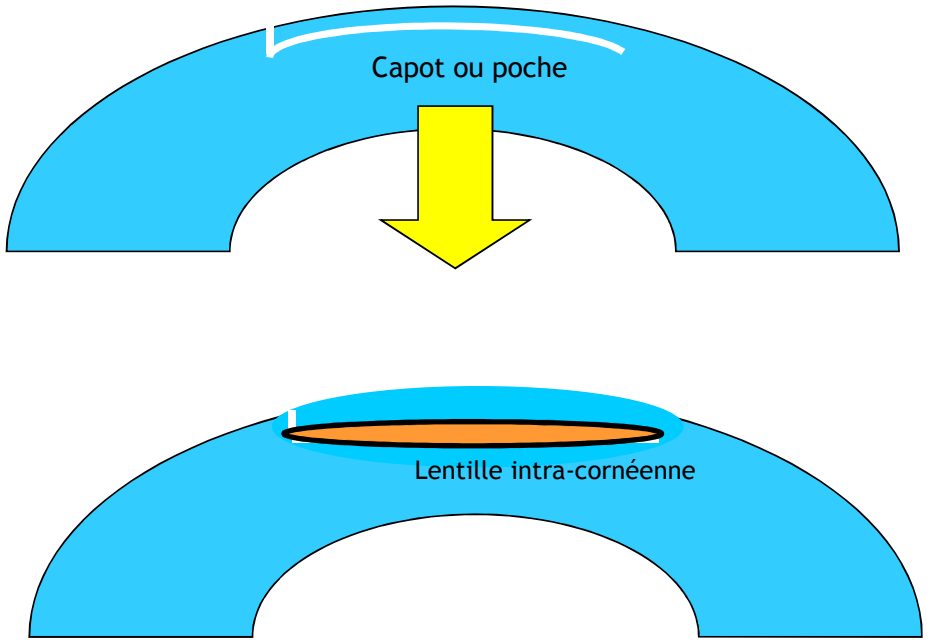


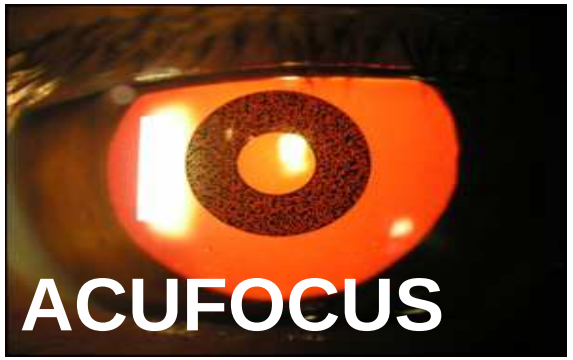


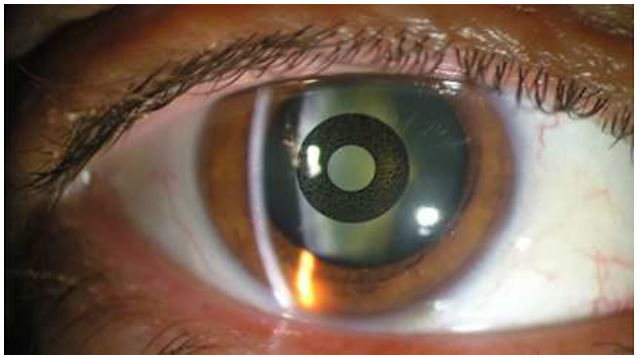




INLAYS intra cornéens réfractifs : une niche











hydrogels, collagens, polysulfones, alloplastics, perfluoropolyether polymer, polyvinyldene fluoride, crosslinked porcine corneal equivalents

MERCI POUR VOTRE ATTENTION