40TH BCLA

CLINICAL CONFERENCE & EXHIBITION

LIVERPOOL : 9-11 JUNE 2017

40 YEARS ANNIVERSARY
BCLA
British Contact Lens Association

BCLA.ORG.UK

TEAR KINETICS IN CONTACT LENS INDUCED DRY EYE

Michel Guillon

BCLA Medal Address – 9th May 2017

Funding Declaration

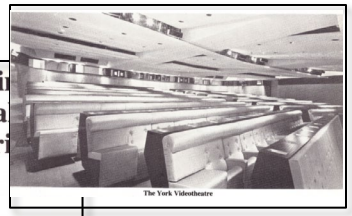
OCULAR TECHNOLOGY GROUP – *International*
receives funding from the following organizations

Alcon Inc.
Allergan Inc.
CooperVision Inc.
Google Verily Life Sciences
Johnson & Johnson Vision Care Inc.
Laboratoires Thea
Santen
URSAPHARM Arzneimittel GmbH

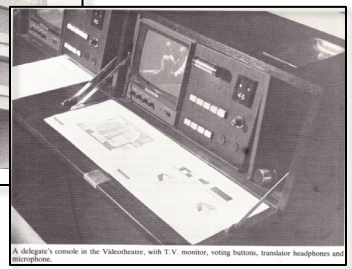
A Constant in my Contact Lens Carrier

Seen at the Civic Reception: John Menon, Andrew Gasson, Jonathan Kersley, David Evershed-Martin, Rosemary Bailey, The Mayor of Scarborough, Michael Jaggs, Sheila Tant, John de Carle, Terry Atkinson, Harry Green, and David Newlove.

The Heathrow Hotel at London Ai
where the BCLA Internationa
Conference will take place on Apri
21, 22 1979.



The York Videotheatre



A delegate's console in the Videotheatre, with T.V. monitor, voting buttons, translator headphones and microphone.

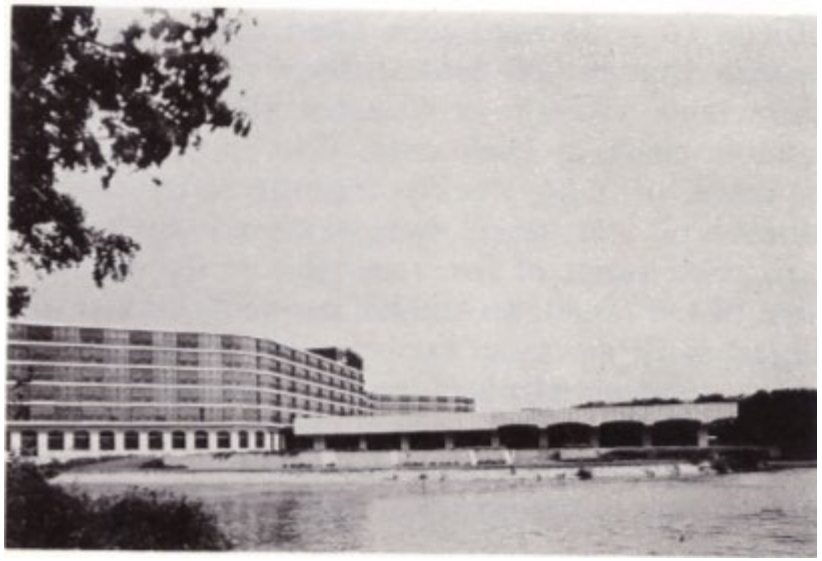
A Constant in my Contact Lens Carrier

Annual Clinical Conference

29th, 30th, 31st May 1981

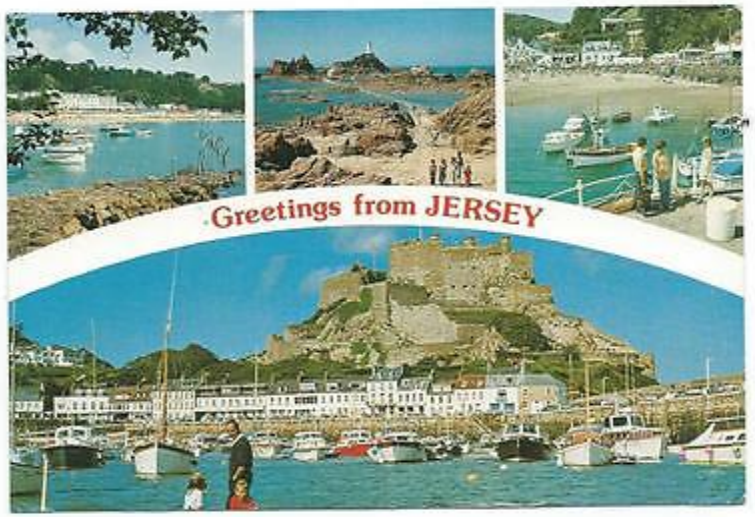
Birmingham Metropole Hotel

than last year. The hotel is situated several miles outside the city in the grounds of the National Exhibition Complex. The lecture, workshops and exhibition areas are adjacent, and the hotel itself has plenty of relaxing areas as well as its own pub "The Cotswold Arms", a coffee shop, and restaurants.



A Constant in my Contact Lens Carrier

BCLA 1986
CLINICAL CONFERENCE PROGRAMME
Hotel de France, Jersey, 23-25 May 1986



A Constant in my Contact Lens Carrier

40 YEARS ANNIVERSARY
BCLA
British Contact Lens Association

The BCLA Medallists

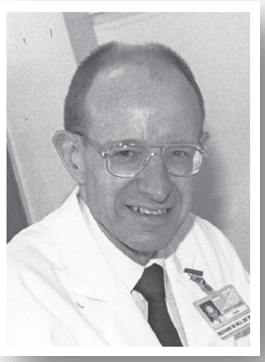
2013

Judith Morris

1994

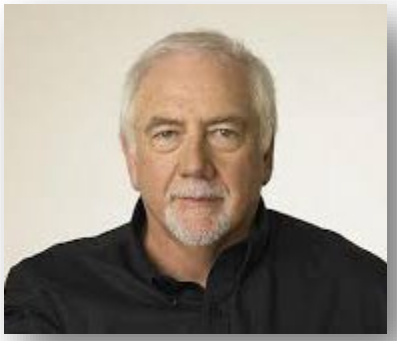
Prof Irving Fatt

1995



Prof Richard Hill

1997



Prof Brien Holden

1993

Prof Otto Wichterle

2009

Prof Deborah Sweeney

2005

Prof Ken Polse

2003

Prof Brian Tighe

Themes

CONTACT LENS INDUCED DRY EYE (CLIDE)
Unique Dry Eye Entity

CAUSATION
Lacrimal System Failure to Maintain Homeostasis

TEAR FILM STABILITY ASSESSMENT
NIBUT Limitations

TEAR KINETICS
Contact Lens Induced Dry Eye ≠ Non-CL Dry Eye

Contact Lens Induced Dry Eye - Terminology

CLIDE or CLD

Special Issue

The TFOS International Workshop on Contact Lens Discomfort: Executive Summary

Jason J. Nichols,[1] Mark D. P. Willcox,[2] Anthony J. Bron,[3] Carlos Belmonte,[4] Joseph B. Ciolino,[5] Jennifer P. Craig,[6] Murat Dogru,[7] Gary N. Foulks,[8] Lyndon Jones,[9] J. Daniel Nelson,[10] Kelly K. Nichols,[1] Christine Purslow,[11] Debra A. Schaumberg,[12] Fiona Stapleton,[2] David A. Sullivan,[13] and the members of the TFOS International Workshop on Contact Lens Discomfort

"a condition characterized by episodic or persistent adverse ocular sensations related to lens wear, either with or without visual disturbance resulting from compatibility between the contact lens and ocular environment"

"the terms "contact lens dry eye" or "contact lens related dry eye" should not be used when talking about contact lens discomfort"

IOVS October 2013: 54 (11) TFOS8-S13

Contact Lens Induced Dry Eye - Terminology

CLIDE or CLD

Special Issue

The TFOS International Workshop on Contact Lens Discomfort: Report of the Contact Lens Interactions With the Ocular Surface and Adnexa Subcommittee

"a link among LIPCOF, conjunctival metaplasia, GCD, MGD, and LWE with CLD, with the strongest evidence being that related to MGD and LWE"

Special Issue

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Jason J. Nichols,[1] Mark D. P. Willcox,[2] Anthony J. Bron,[3] Carlos Belmonte,[4] Joseph B. Ciolino,[5] Jennifer P. Craig,[6] Murat Dogru,[7] Gary N. Foulks,[8] Lyndon Jones,[9] J. Daniel Nelson,[10] Kelly K. Nichols,[1] Christine Purslow,[11] Debra A. Schaumberg,[12] Fiona Stapleton,[2] David A. Sullivan,[13] and the members of the TFOS International Workshop on Contact Lens Discomfort

"the feature with the strongest link to ocular comfort during CL wear is tear film instability"

Special Issue

The TFOS International Workshop on Contact Lens Discomfort: Report of the Contact Lens Interactions With the Ocular Surface and Adnexa Subcommittee

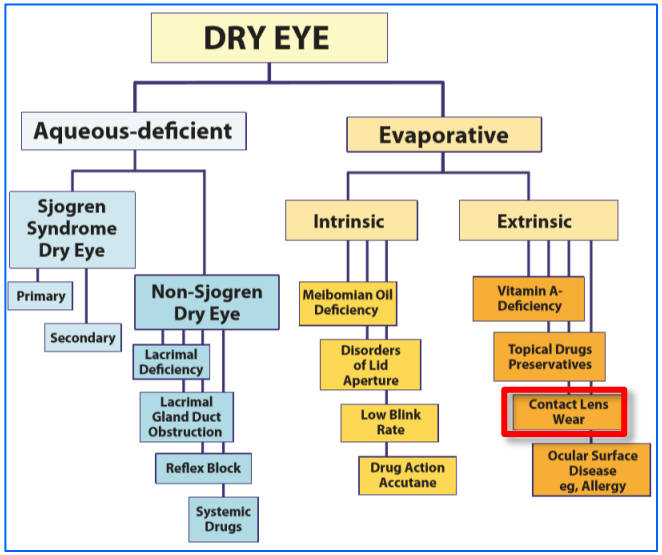
"CL that generates CLD via neurobiological mechanisms include its physical interaction with the ocular surface, induction of hyperosmolarity and the presence of chemical mediators"

IOVS October 2013: 54 (11) TFOS98-S122 IOVS October 2013: 54 (11) TFOS71-S97 IOVS October 2013: 54 (11) TFOS123-S156

Contact Lens Induced Dry Eye - Terminology

CLIDE or CLD

DEWS



DEWS II

"Dry eye is a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles"

Contact Lens Induced Dry Eye

The Ocular Surface 2007: 5 (2) 75-92

www.cclsa.org.au Post may 9th, 2017

Contact Lens Induced Dry Eye - Symptomatology

CLIDE vs. Non-CL DE

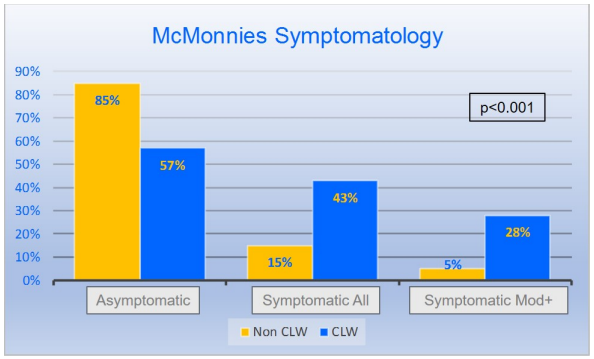
Dry Eye Symptomatology of Soft Contact Lens Wearers and Nonwearers

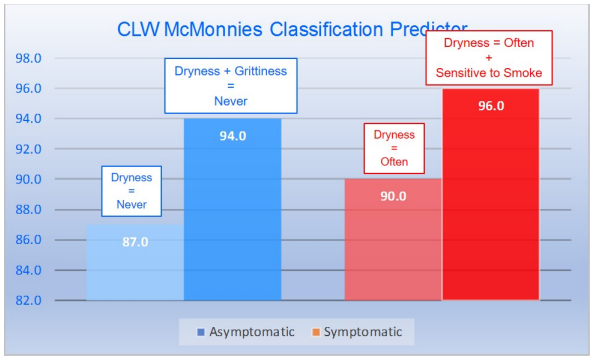
MICHEL GUILLON, PhD, FAAO, and CÉCILE MAISSA, PhD

Optometric Technology Group Research & Consultancy, London, United Kingdom

Optometry and Vision Science, Vol. 82, No. 9, September 2005

	Soft contact lens wearers	Noncontact lens wearers
No.	502	309
Male:female	166:336	135:174
Age (years)	34 ± 10 (17–69)	36 ± 13 (16–72)





CL Presence Induces Symptoms
CLIDE Dominant Symptom = “Dryness”

Contact Lens Induced Dry Eye - Symptomatology

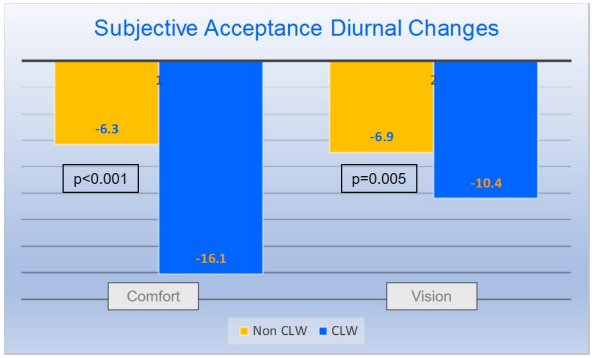
CLIDE vs. Non-CL DE

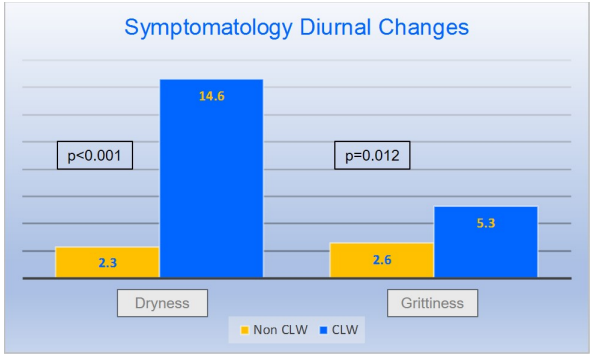
Diurnal Variation in Comfort in Contact Lens and Non-contact Lens Wearers

Kathryn A. Dumbleton*, Michel Guillon*, Panagiotis Theodoratos†, and Trisha Patel‡

Optometry and Vision Science, Vol. 93, No. 8, August 2016

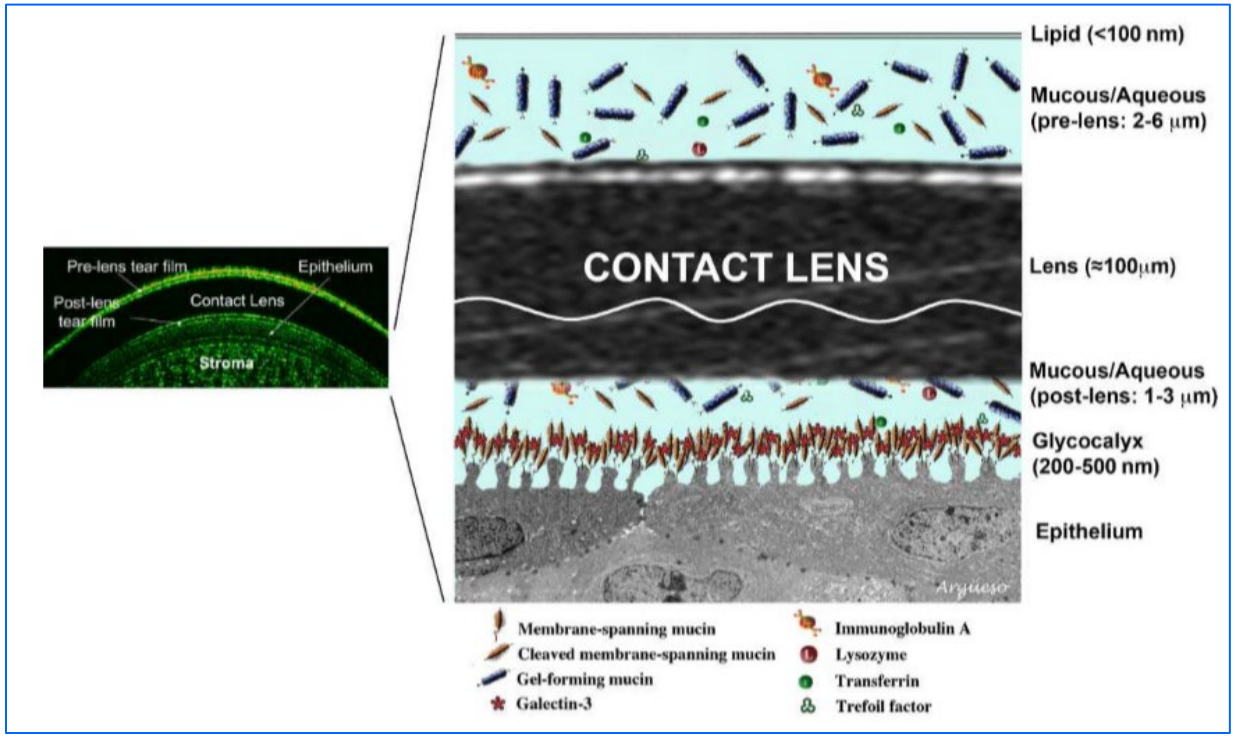
Variable	CLW	NW
Number (n)	381	259
Age (yr)	29.89 ± 10.07 18–40 yr: 315 (83%) >40 yr: 66 (17%)	35.41 ± 13.69 18–40 yr: 164 (63%) >40 yr: 95 (37%)
Sex	135 male (35.4%) 246 female (64.6%)	106 male (40.9%) 153 female (59.1%)





Symptom Diurnal Changes CLW > Non-CLW

Contact Lens & Tear Film Biophysical Considerations



CL Presence = TF Physical Disruption

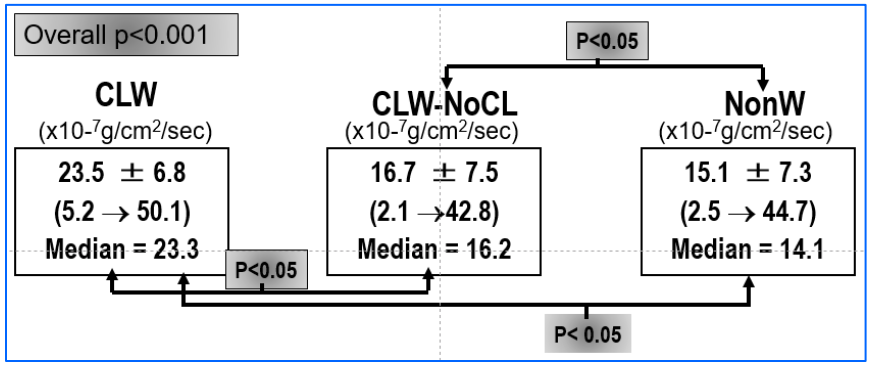
IOVS October 2013: 54 (11) TFOS124

Contact Lens & Tear Film Biophysical Considerations

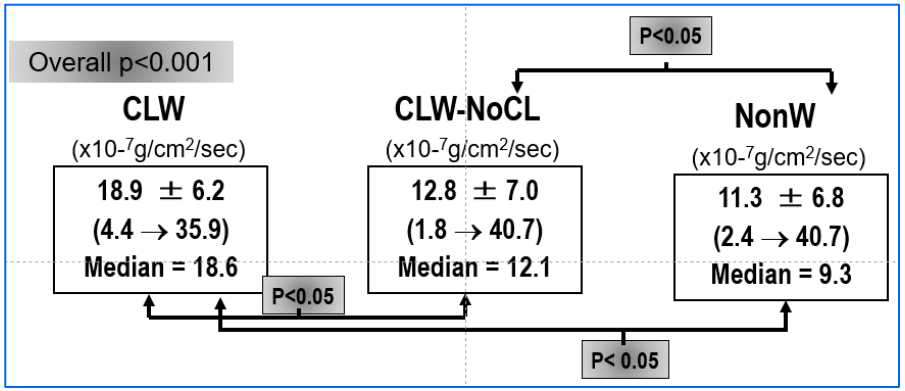
Contact Lens Wear Affects Tear Film Evaporation

Michel Guillon, Ph.D., F.C.Optom., F.A.A.O., F.B.C.L.A., C.T.T.I., and Cécile Maissa, Ph.D

30% Humidity Environment



40% Humidity Environment

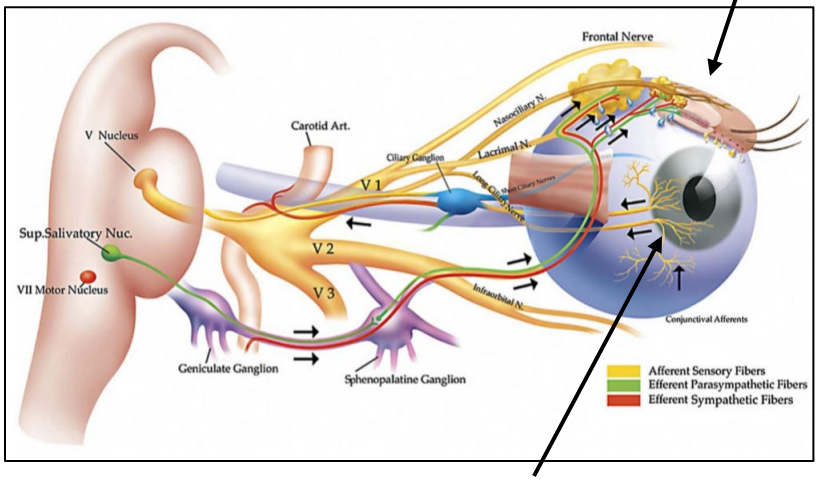


CLW Presence = Dry Environment

Eye & Contact Lens 2008. 34:326-330

Contact Lens & Corneal Sensory Mechanism

Cold Receptors
Control
Reflex Blinking
Basal Tear Production



10-15% Corneal Sensory Nerves = Cold Receptors*

TF Evaporation

↓

Corneal Surface Cooling
Increased Osmolarity

↓

Cold Receptors Detect Both

↓

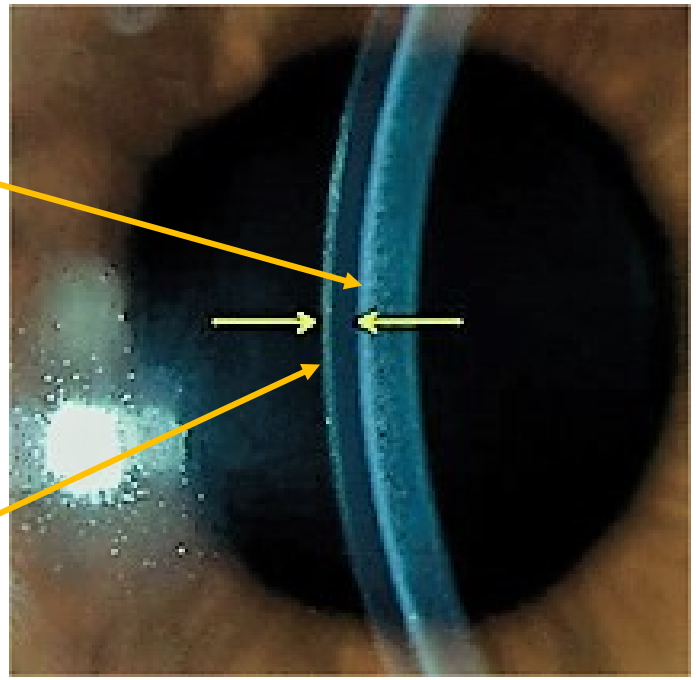
Reflex Blinking

* Threshold <0.5°C

Investigative Ophthalmology & Vision Science 2013: S9

Contact Lens & Corneal Sensory Mechanism

Post Lens TF Warmer than Pre Cornea TF



Pre Lens TF Colder than Pre Cornea TF

Corneal Surface Partially Insulated from Environmental Changes

CL Presence Affects Cold Receptors Blink Reflex Mechanism

Key Contributor to CLIDE

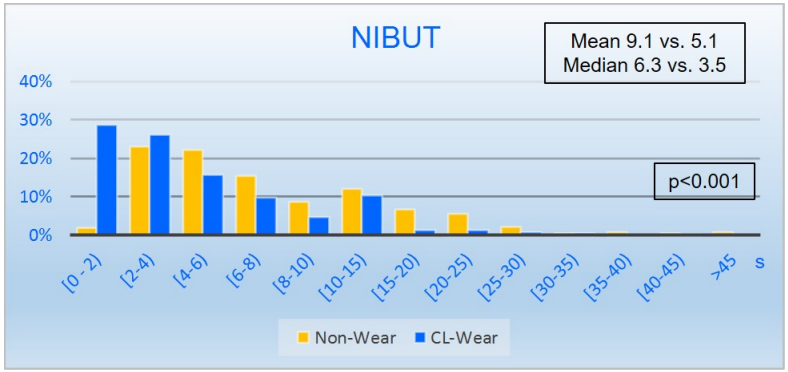
Purslow et al cited in Investigative Ophthalmology & Vision Science 2013: S128

NIBUT – CL vs. Cornea

Contact Lens and Corneal Tear Film Kinetics are Different

Michel Guillon, Panos Theodoratos, Kathy Dumbleton

Group	Age (yrs)	Sex	N
Non CLW	37.3 ± 12.9	M 36% F 64%	133
CLW	29.5 ± 9.4	M 33% F 66%	202



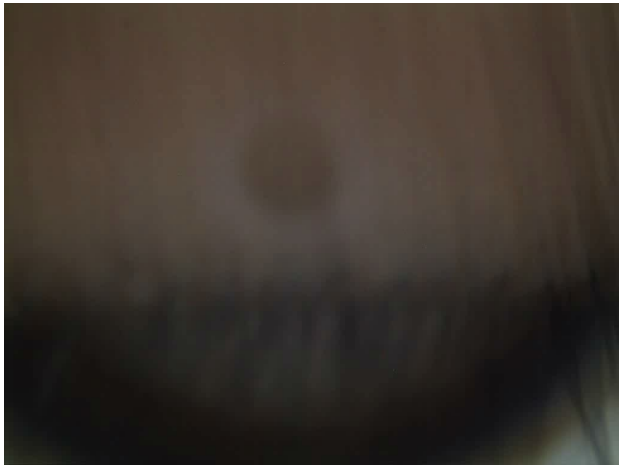
CL Presence = Shorter NIBUT than Non-CL

CL & Non-CL Distributions Overlap

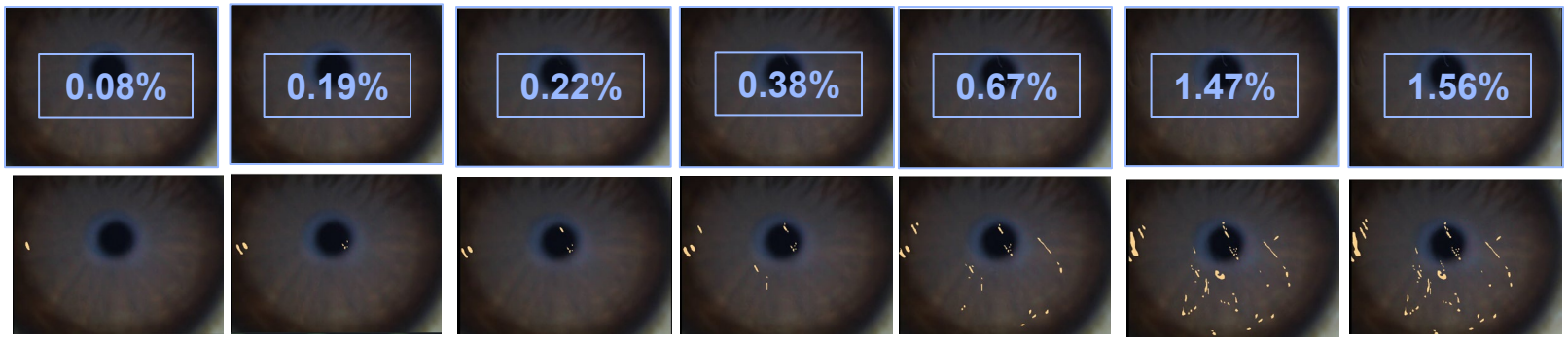
American Academy of Optometry , 2015

Tear Film Kinetics – The Full Story

NIBUT = 5.2s



IB = 10.4s



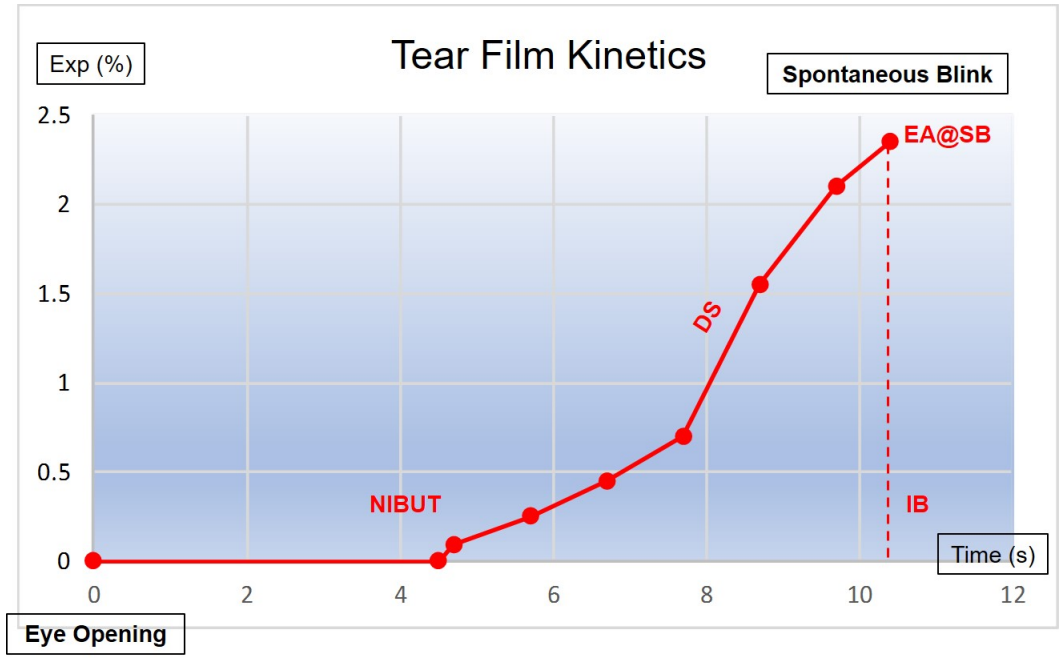
Tear Film Kinetics – The Full Story

NIBUT = 6.2s

IB = 39.7s

Tear Film Kinetics – The Full Story

EXPOSED AREA @ SPONTANEOUS BLINK
Status of the contact lens surface at time of the blink

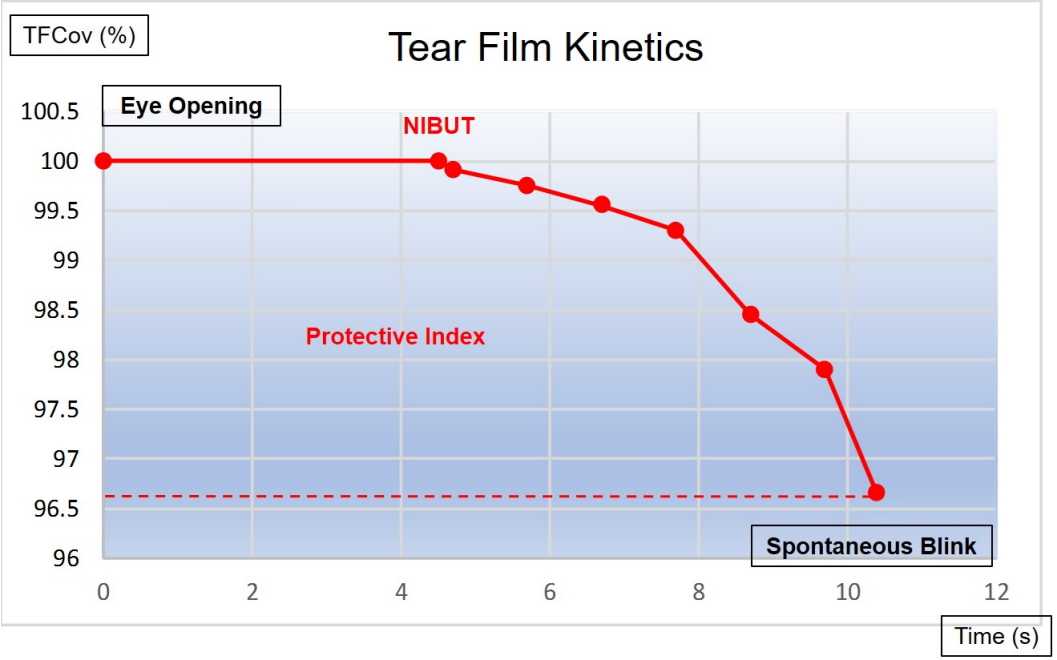


DRYING SPEED
Contact lens surface exposure speed between initial break and blink

NIBUT
Length of time when tear film performance is optimal

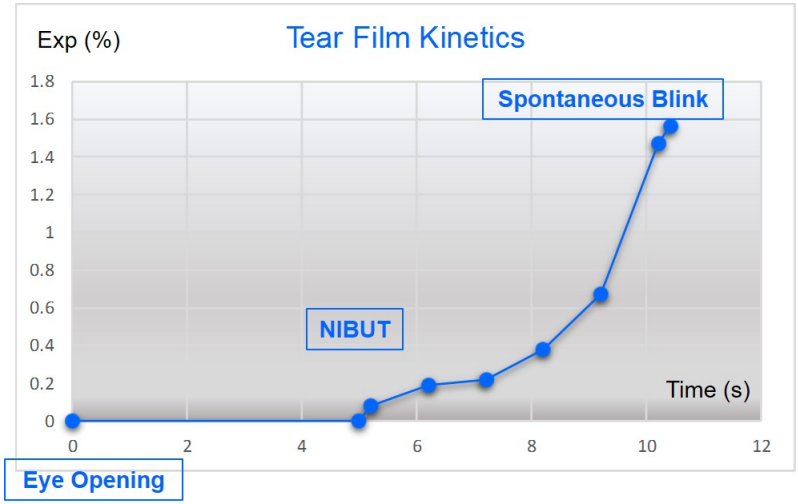
Tear Film Kinetics – The Full Story

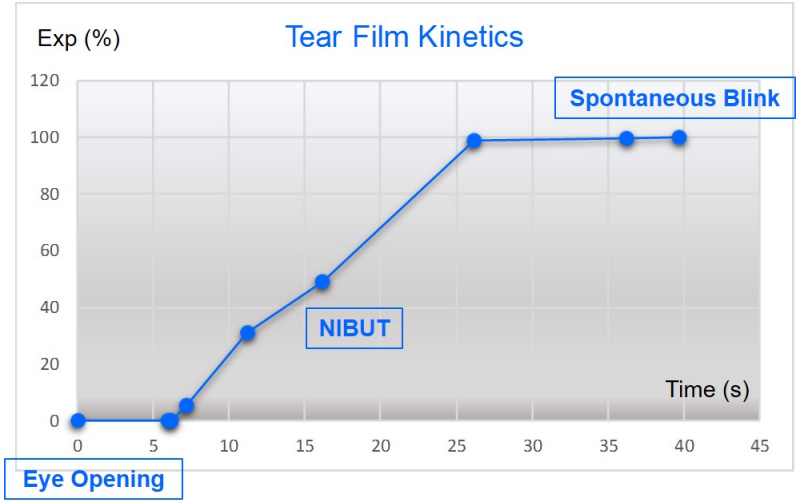
NIBUT
Length of time when tear film performance is optimal



PROTECTIVE INDEX
Percentage of contact lens surface covered by the tear film during the interblink period

Tear Film Kinetics – The Full Story





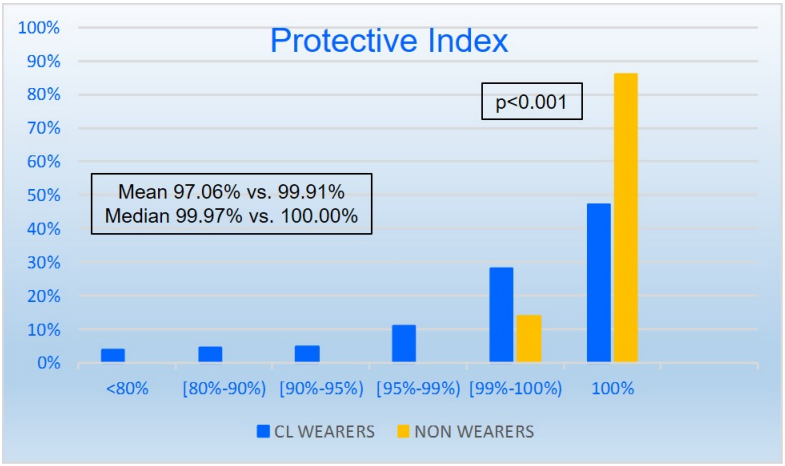
NIBUT (s)	5.2
IB	*10.4s*
DS	*0.17mm^2/s*
EA@SB	*1.6%*
MPA	*98.4%*
PI	*99.8%*

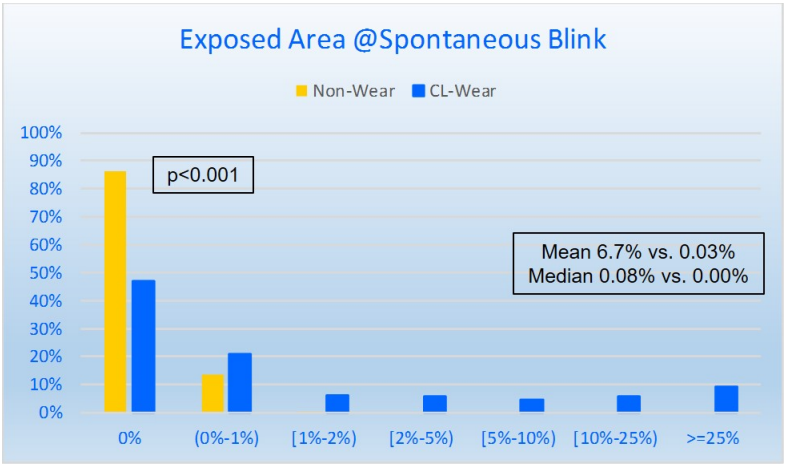
NIBUT (s)	6.2
IB	*39.7s*
DS	*1.75mm^2/s*
EA@SB	*99.8%*
MPA	*0.2%*
PI	*55.8%*

Tear Film Kinetics – CL vs. Cornea

Contact Lens and Corneal Tear Film Kinetics are Different

Michel Guillon, Panos Theodoratos, Kathy Dumbleton





CL Presence = Lower Overall Surface Protection & Greater Surface Exposure @ Blink

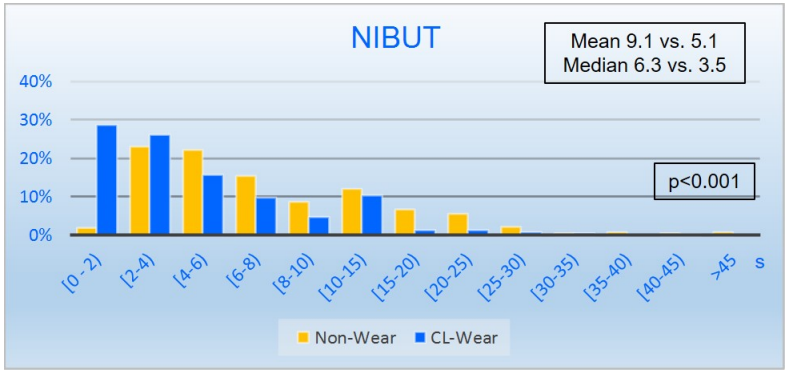
CL & Non-CL Large Distribution Differences

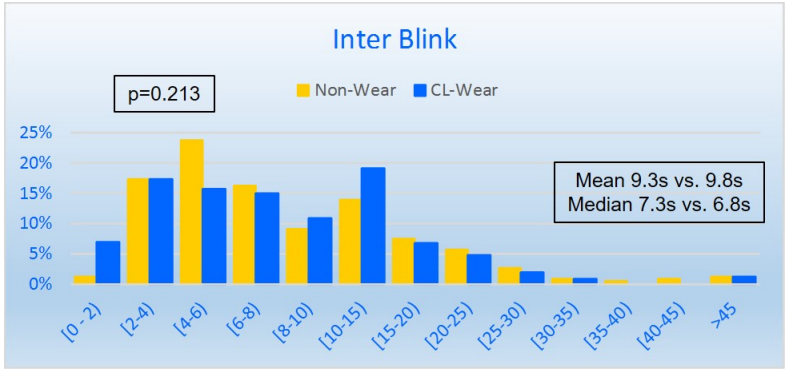
American Academy of Optometry , 2015

Tear Film Kinetics – CL vs. Cornea

Contact Lens and Corneal Tear Film Kinetics are Different

Michel Guillon, Panos Theodoratos, Kathy Dumbleton





NIBUT vs. IB CORRELATION			
Group	**Overall**	**Asymptomatic**	**Symptomatic**
Non CLW	0.935	0.930	0.941
CLW	0.600	0.630	0.487

CL Presence = Poorer NIBUT/IB Correlation

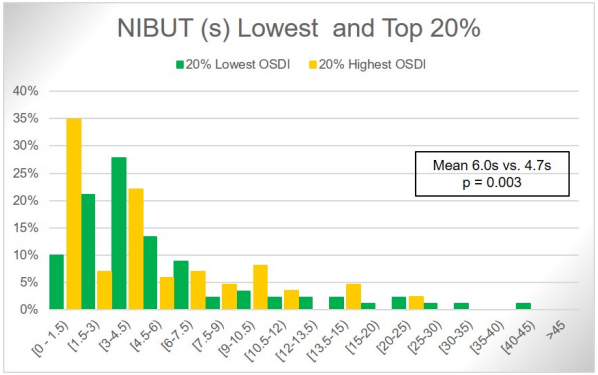
CL Presence = Symptomatic Poorer NIBUT/IB than Asymptomatic

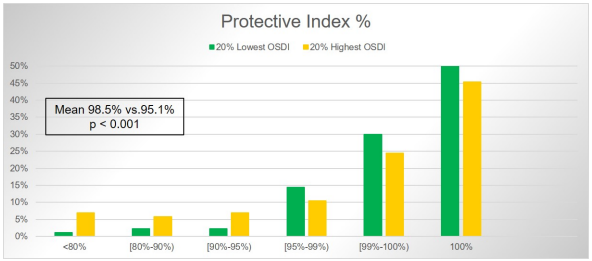
American Academy of Optometry , 2015

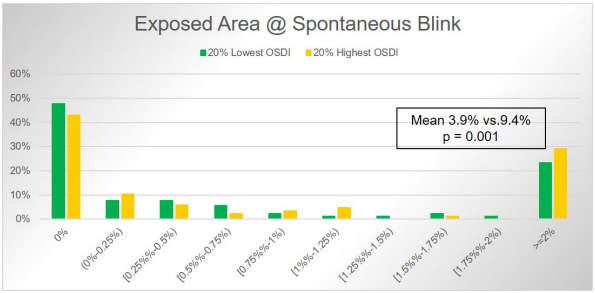
Tear Film Kinetics – Asymptomatic vs. Symptomatic

Association Between Contact Lens Discomfort and Pre-lens Tear Film Kinetics

Michel Guillon*, Kathryn A. Dumbleton*, Panagiotis Theodoratos†, Stephanie Wong‡, Kishan Patel§, Gaidig Banks‖, and Trisha Patel§







Tear Film Kinetics

Asymptomatic > Symptomatic

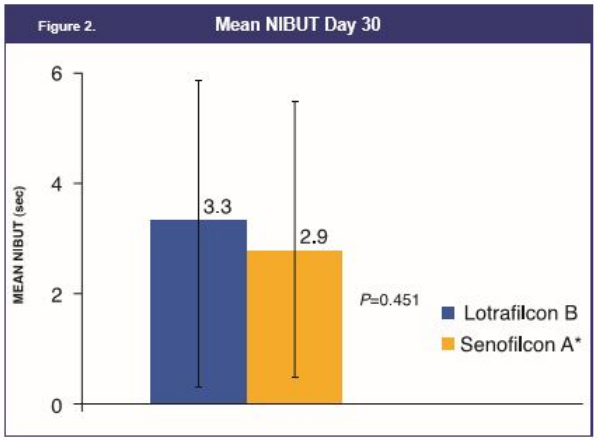
Optometry & Vision Science 2016: 92

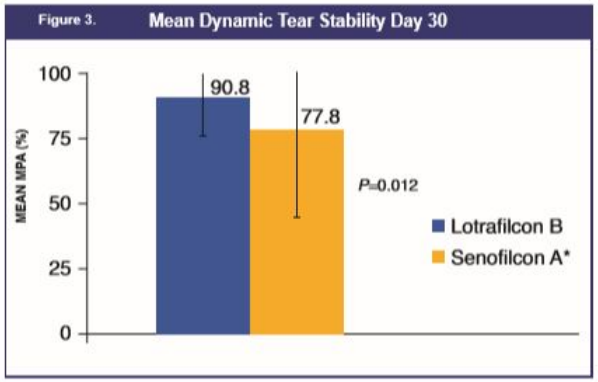
Tear Film Kinetics – Planned Replacement End of Wear

Tear Film Dynamics over Silicone Hydrogel Contact Lenses with Different Lipid Deposition Profiles

Michel Guillon, Cecile Maissa, Stephanie Wong, Trisha Patel, Jessie Lemp

Symptomatic High Depositor
lotrafilcon B (1M) & senofilcon A (2W)
n =67





PR & High Depositors = CL Material Differences in Tear Film Kinetics

(Not Detected by NIBUT)

Optometry & Vision Science 2016: 92

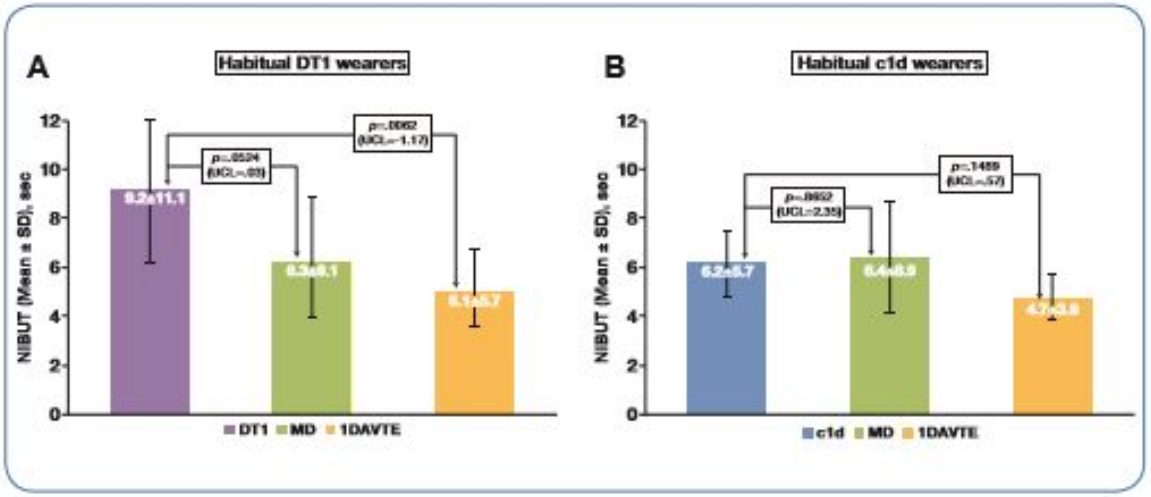
Tear Film Kinetics – Daily Disposable Dry Environment

Comfort and wettability of Daily Disposable Contact Lenses

Kathy Dumbleton, Michel Guillon, Trisha Patel, Kishan Patel, Cecile Maissa,

Habitual DAILIES® TOTAL 1®	Habitual clariti® 1 day
MyDay™ & 1-DAY ACUVUE® TruEye®	
Post 3 Hours Computer Use under 20% Hygrometry	

NIBUT



DD & Adverse Environment = CL Material Differences in Tear Film Stability

Tear Film Ocular Society, 2016:

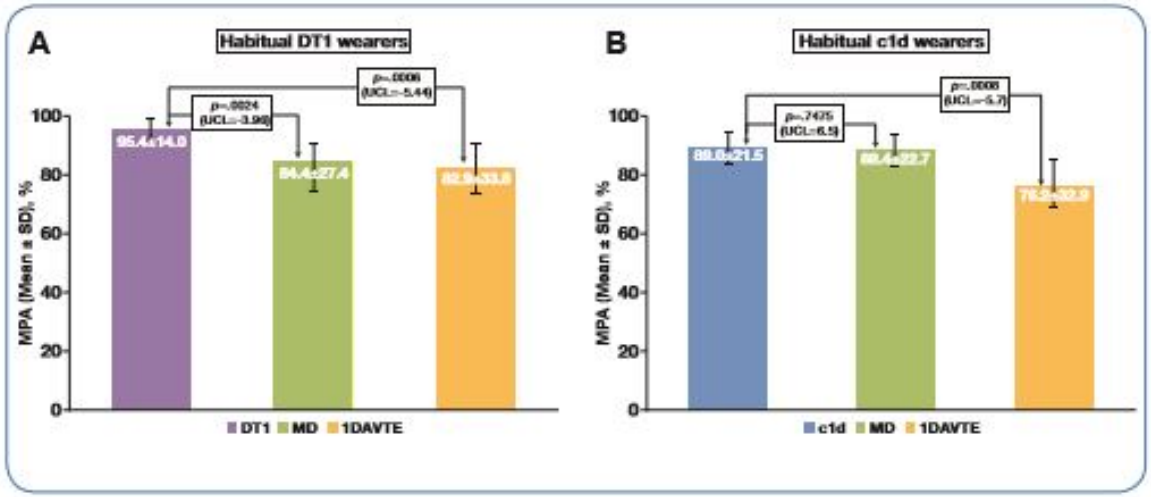
Tear Film Kinetics – Daily Disposable Dry Environment

Comfort and wettability of Daily Disposable Contact Lenses

Kathy Dumbleton, Michel Guillon, Trisha Patel, Kishan Patel, Cecile Maissa,

Habitual DAILIES® TOTAL 1®	Habitual clariti® 1 day
MyDay™ & 1-DAY ACUVUE® TruEye®	
Post 3 Hours Computer Use under 20% Hygrometry	

MPA = 1- EA@SB



DD & Adverse Environment = CL Material Differences in CL Surface Exposure

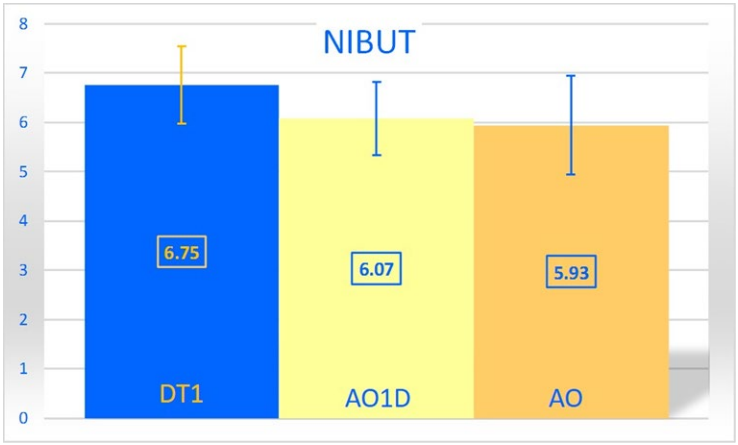
Tear Film Ocular Society, 2016:

Tear Film Kinetics – Daily Disposable Initial Wettability

Daily Disposable Contac Lenses Initial On-Eye Wettability

Michel Guillon, Kishan Patel, Ruchi Gupta, Trisha Patel, Cecile Maissa

Habitual DAILIES® TOTAL 1®
ACUVUE® OASYS® &ACUVUE® OASYS® Daily
3 Hours of Wear after 10 Days Pre-adapatation



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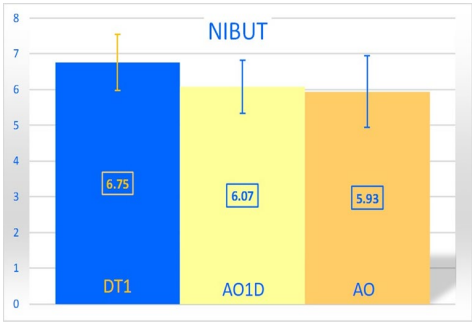

DD Initial Wettability = Trend Towards CL Material Differences

British Contac Lens Association, 2017

Tear Film Kinetics – Daily Disposable Initial Wettability

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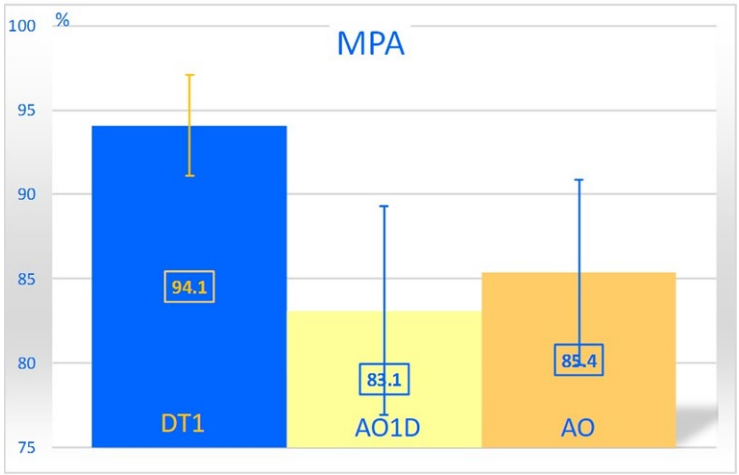
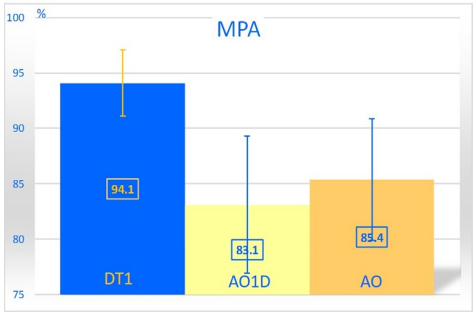


CL Type	Mean (%)	95% CI (%)
AO1D - DT1	-11	-17.5 to -4.6
AO - DT1	-8.6	-14.0 to -3.1



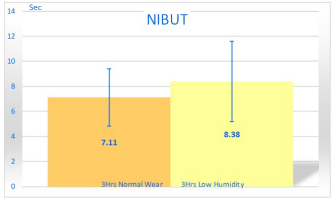
DD Initial Wettability = CL Material Differences in CL Surface Exposure

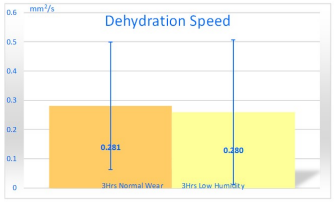
British Contac Lens Association, 2017

Tear Film Kinetics – Repeatability

Habitual DAILIES® TOTAL 1®
Initial 3Hrs Wear & Post 3Hrs Wear at 20% Hygrometry
Study 1 n = 90 & Study 2 n =58

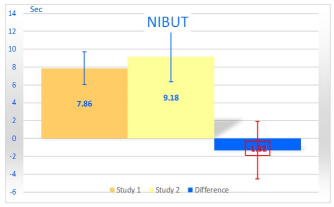
Initial 3Hrs

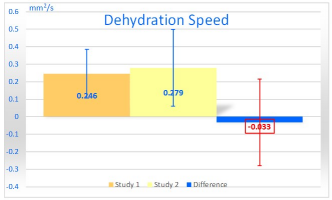




	Mean Diff (95%CID) Study 1 vs. Study 2
NIBUT (s)	0.9 (-3.2 to +1.4)
DS (mm²/s)	0.00 (-0.22 to +0.22)
MPA (%)	2.0 (-3.5 to +7.4)

Post 3Hrs Low Humidity





	Mean Diff (95%CID) Study 1 vs. Study 2
NIBUT (s)	1.3 (-4.5 to +1.9)
DS (mm²/s)	0.03 (-0.28 to +0.22)
MPA (%)	0.3 (-3.9 to +4.3)

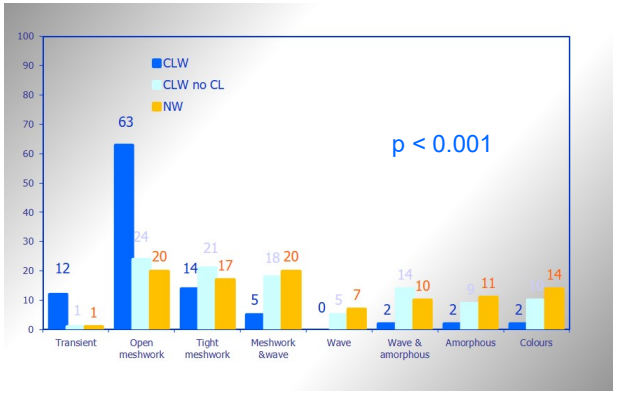
DT1 TFK Consistent Across Studies TFK Methodology Repeatable

Association for Research in Vision and Ophthalmology, 2017

Lipid Layer Pattern – CL vs. Cornea

Tear Film and Lipid Layer Dynamics
Michel Guillon, Cecile Maissa

	Mean Diff (95%CID) Study 1 vs. Study 2
NIBUT (s)	0.9 (-3.2 to +1.4)
DS (mm^2/s)	0.00 (-0.22 to +0.22)
MPA (%)	2.0 (-3.5 to +7.4)



	Thin Layer	Average Layer	Thick Layer
CLW	12.2%	76.3%	11.5%
CLW no CL	0.5%	44.4%	55.1%
NW	1.4%	37.6%	61.0%

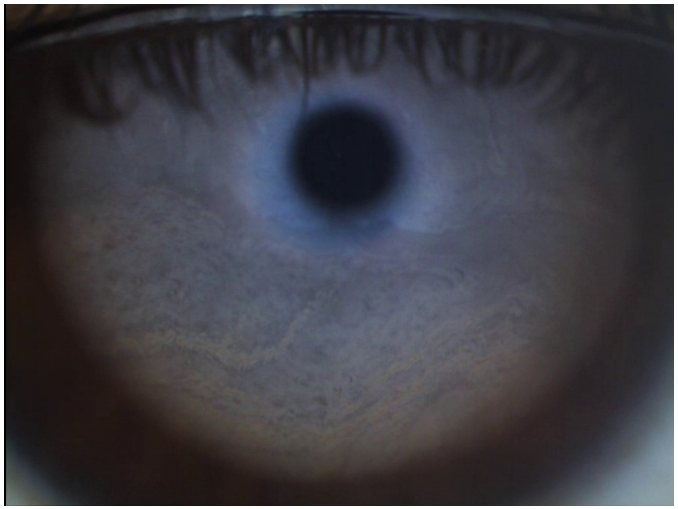
CL Presence = Thinner Lipid Layer

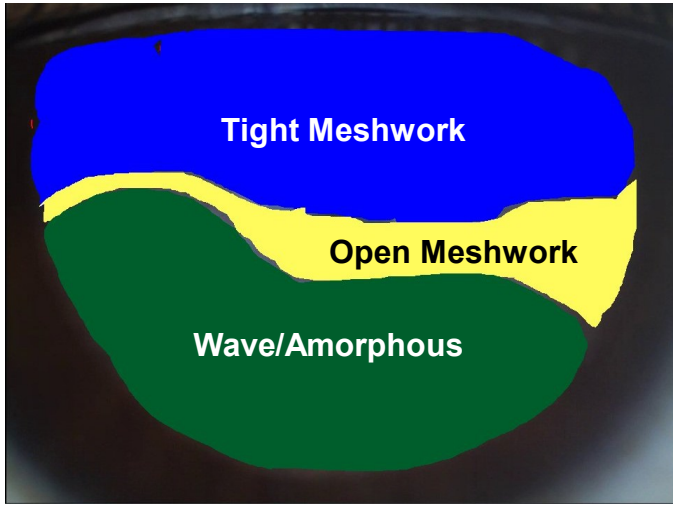
Association for Research in Vision and Ophthalmology, 2008

Tear Lipid Kinetics – The Full Story

Lipid Layer Thickness (LLT)

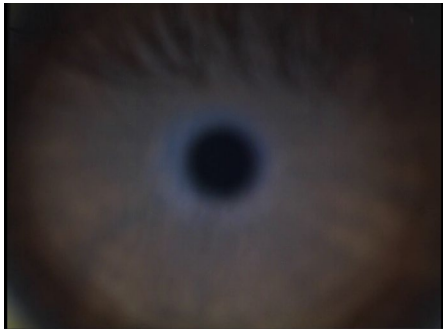
[(Average thickness of primary lipid pattern (nm) x %Area) +
∑ (Average thickness of subsequent lipid patterns (nm) x %Area)]

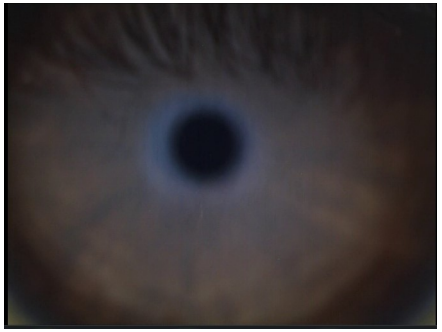


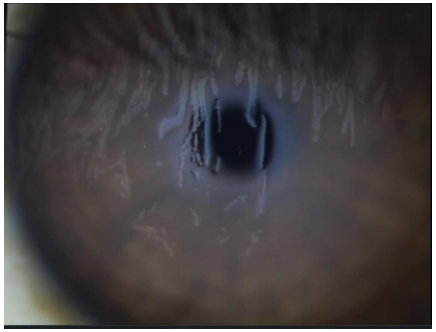


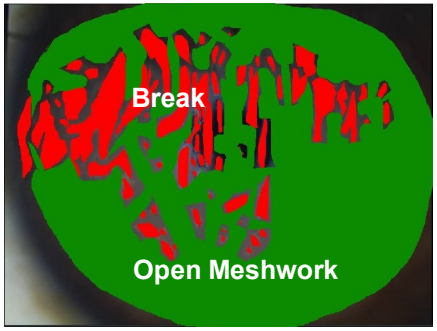
Large Topographic Variability in LLT

Tear Lipid Kinetics – The Full Story









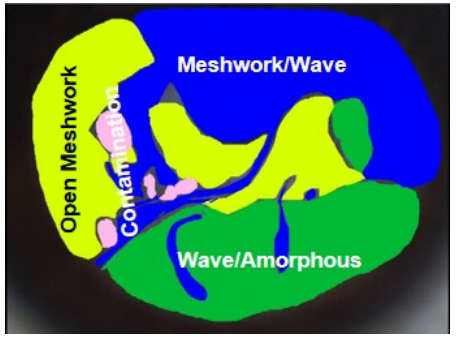
15.0nm

15.0nm

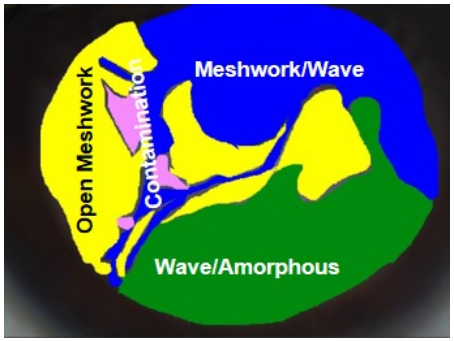
12.7nm

Thin Even Unchanged Layer over Interblink

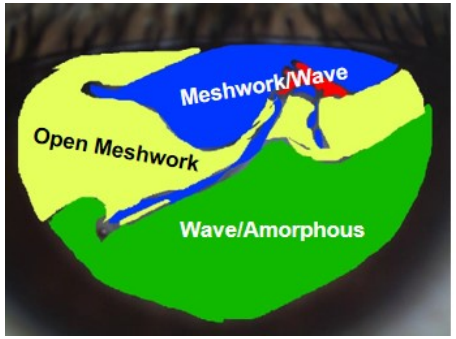
Tear Lipid Kinetics – The Full Story



33.6nm



34.9nm



40.8nm

Average Thickness Uneven Layer Increasing over Interblink

Tear Lipid Kinetics – PR SiHy

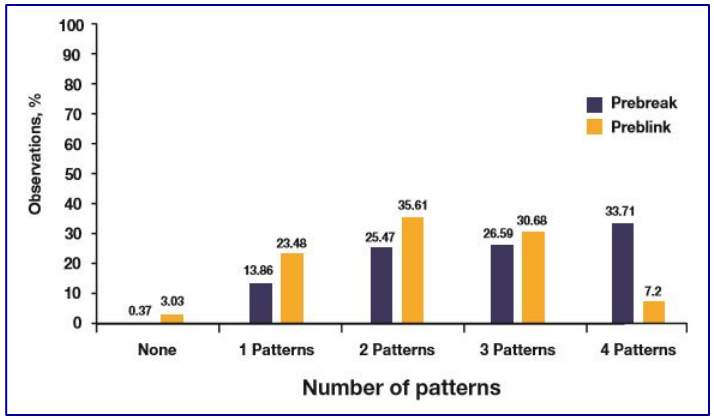
Tear Film Kinetics of the Pre Contact Lens Tear Lipid Layer

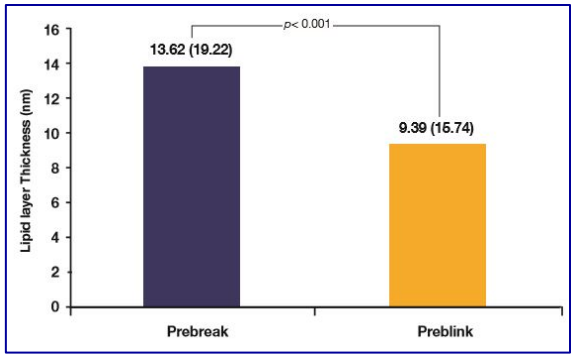
Jessie Lemp, Cecile Maissa, Kathy Dumbleton, Stephanie Wong, Trisha Patel, Gaidig Le Minor, Michel Guillon

PATTERN

Symptomatic High Depositor
Iotrafilcon B (1M) & senofilcon A (2W)
n =67

THICKNESS





TLL Thickness in High Depositors Complex & Thinning over Interblink

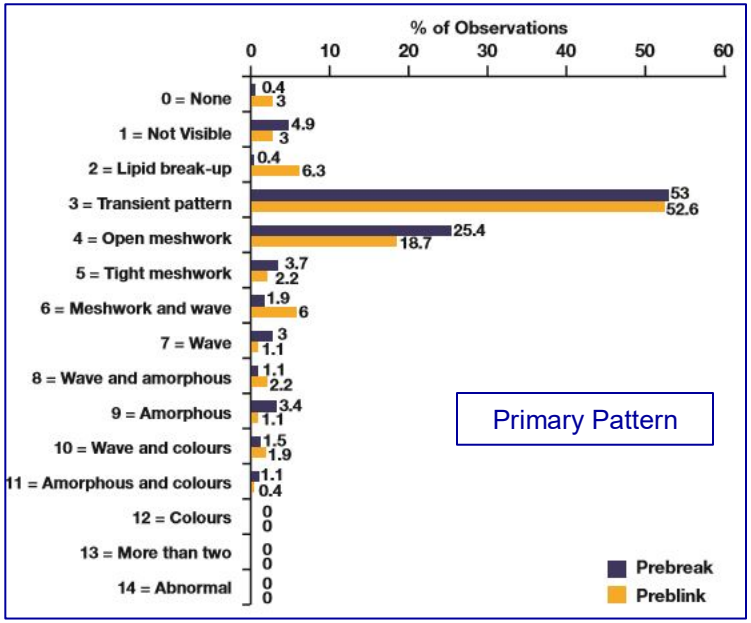
Topographic & Time Dependent Analysis Essential

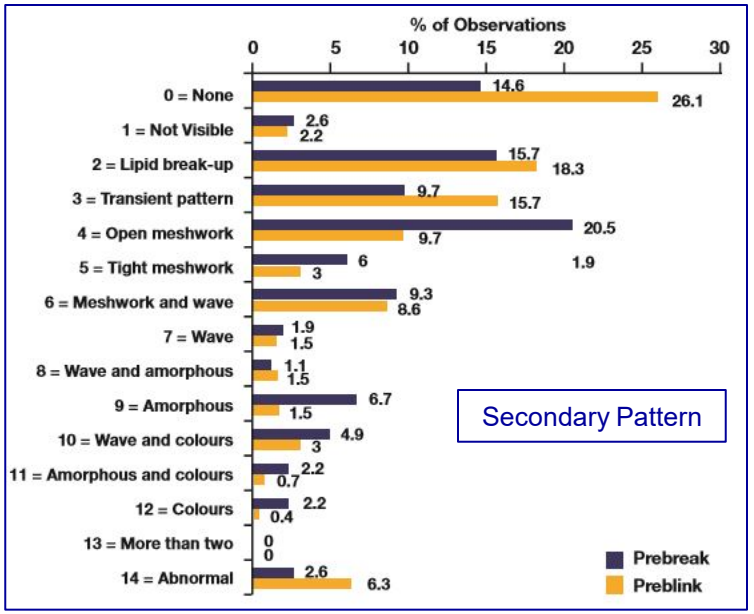
British Contact Lens Association, 2015

Tear Lipid Kinetics – PR SiHy

Tear Film Kinetics of the Pre Contact Lens Tear Lipid Layer

Jessie Lemp, Cecile Maissa, Kathy Dumbleton, Stephanie Wong, Trisha Patel, Gaidig Le Minor, Michel Guillon





Transient to Absent Pattern Most Prevalent in Symptomatic High Depositors CLW

American Academy of Optometry, 2014

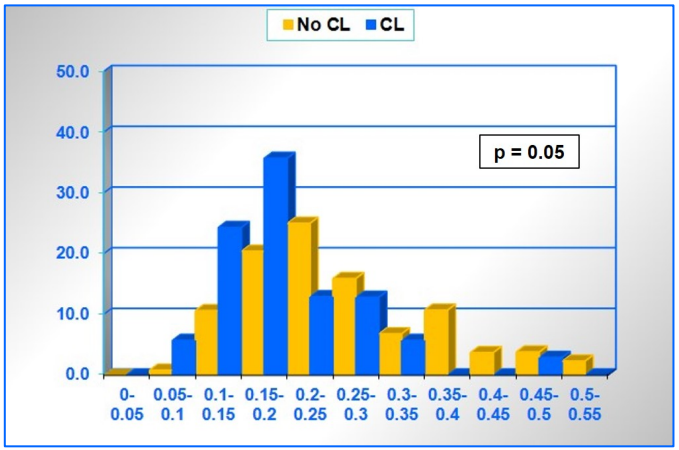
Tear Prism Height – CL vs. Cornea

Tear Volume Assessment in Contact Lens Wearers and Non Wearers

Michel Guillon, Cecile Maissa, Shruti Varsani, Stephanie Wong

Age (Yrs)	32.8±13.0
Gender	Male 44% Female 56%
Group	CLW 33% No CLW 67%
N	101

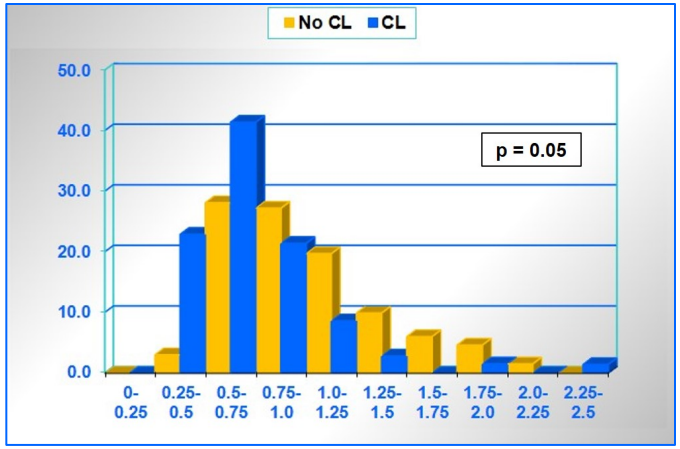
Tear Prism Height



Tear Prism Height	
Non CLW	0.26 ± 0.10mm
CLW	0.19 ± 0.08mm

Tear Prism Area	
Non CLW	1.00 ± 0.39mm^2
CLW	0.72 ± 0.33mm^2

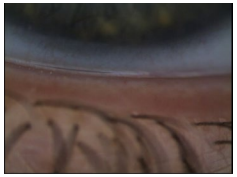
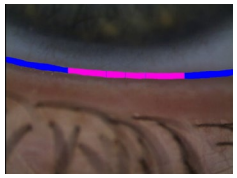
Tear Prism Area



Lower Tear Volume In CLW than Non CLW

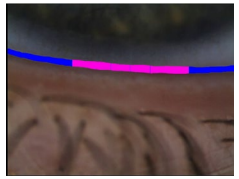
American Academy of Optometry , 2009

Tear Volume Kinetics – The Full Story

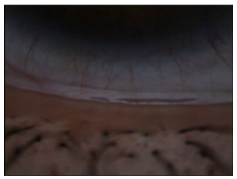
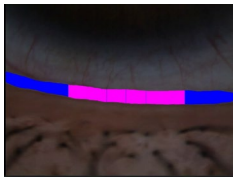
0.92mm²

Opening



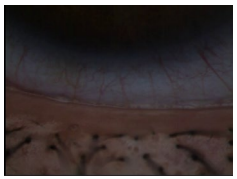
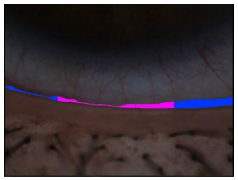
0.96mm²

Blink

1.85 mm²

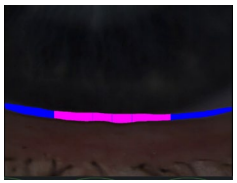
Opening

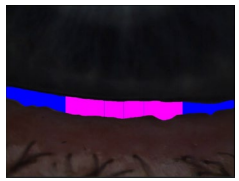
0.56 mm²

Blink

1.07 mm²



Opening



2.09 mm²

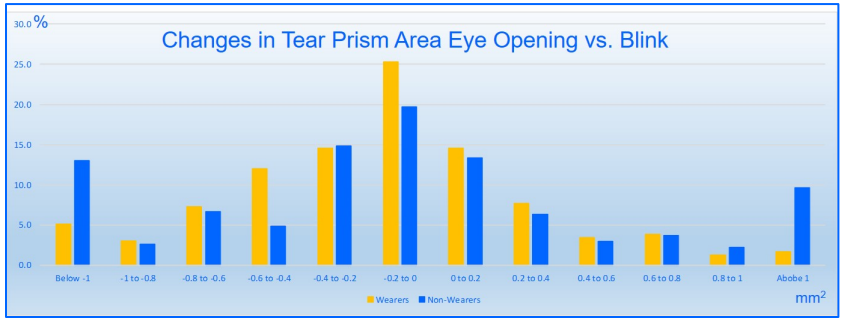
Blink

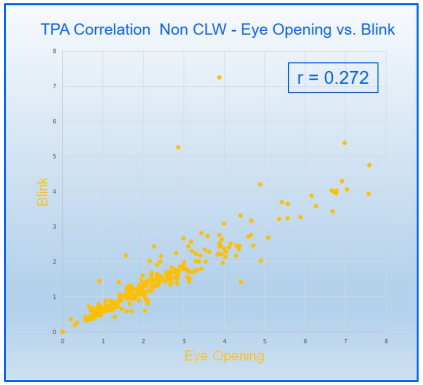
Tear Volume Kinetics – Eye Opening vs. Blink

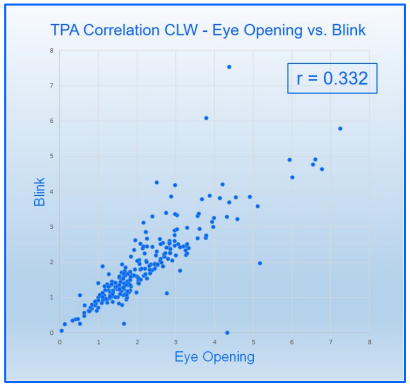
Tear Volume Changes Over the Interblink Period

Michel Guillon, Kathy Dumbleton, Kishan Patel, Ruchi Gupta, Paris Pariza

	Age (Yrs)	N
Non CLW	42.6 ± 13.0	134
CLW	33.9 ± 10.0	129







Tear Prism Area Variable over Interblink Period

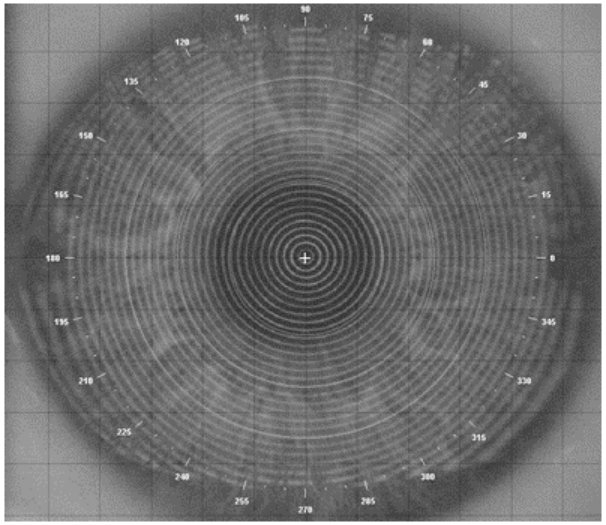
Tear Prism Area Eye Opening vs. Blink Low Correlation

Tear Film Ocular Society, 2016

Tear Film Kinetics Measurement Technologies

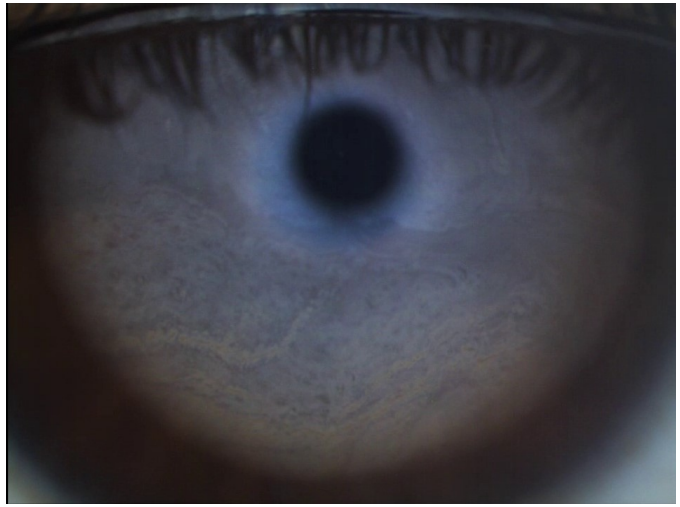
Two Technologies Available

Placido Disk



Distortion of Reflected Pattern
=
Tear Film Changes

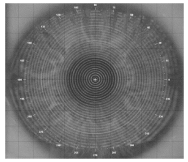
Tearscope

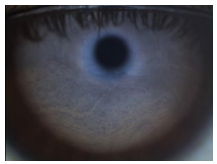


Modification in the Image Reflected Light Source
=
Tear Film Changes

Tear Film Kinetics Measurement Technologies

Two Technologies Available





Placido Disk Challenges

TECHNOLOGY

1. Initial Break Detection
2. Differentiation Between TF Thinning & Break

CLINICAL USAGE

1. Small Palpebral Apertures
2. Poor Tear Film Quality
3. Contact Lenses

Tearscope Challenges

TECHNOLOGY

1. Analysis Automation

CLINICAL USAGE

1. Precise Focusing

Conclusion

CLIDE Unique Dry Eye Entity

UNIQUE SYMPTOMATOLOGY

High prevalence in Young Population

Very Large Diurnal Increase

UNIQUE TEAR FILM KINETICS

Poor Tear Film Stability
(Shorter NIBUT)

Poor Wetting Characteristics
(Greater Surface Exposure &
Dissociation With Spontaneous Blink)

CLIDE Causation – Failure to Maintain Homeostasis

TEAR FILM ANOMALIES

Short Break-up
Rapid Tear Film Breaking
High Surface Exposure
Reduced Tear Volume
Lack of Coordination between Tear Film Breaking & Spontaneous Blink)

Conclusion

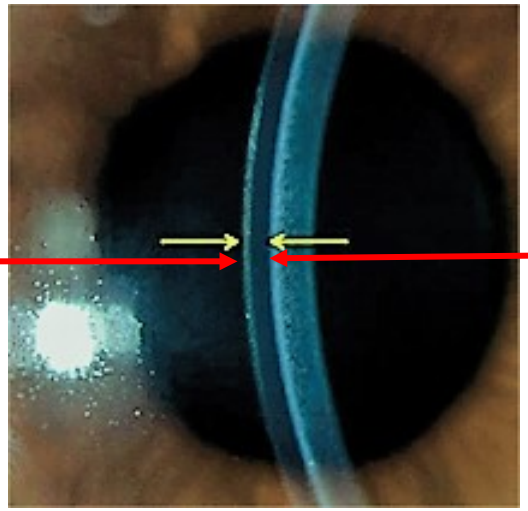
CLIDE Tear Film Assessment

NIBUT
Limited Clinical Indicator: Duration of Good Wettability

FULL TEAR KINETICS
Protective Index: Level of Protection over IB
Exposed Area @ Blink: Surface CL Status @ Blink
Lipid Layer Thickness: Protection Efficacy vs. Evaporation
Tear Film Volume : Effect of CL on Basal Lacrimation

Conclusion

CLIDE Tear Biophysical Mechanism



Alteration of Tear Film Biomechanics Compared with Cornea

↓

Modification of Tear Film Homeostasis

Corneal Surface Partial Insulation from Environmental Changes

↓

Modification of Corneal Cold Receptors Sensing & Reflex Blinking

Disassociation Between Tear Film Biomechanics & Reflex Blinking

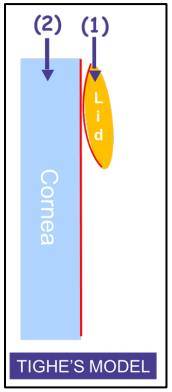
↓

Large Contact Lens Surface Exposure at Time of Blinking

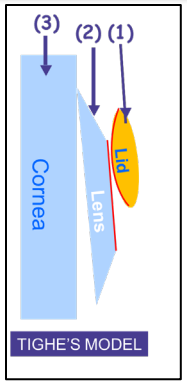
Conclusion

CLIDE Tear Biophysical Mechanism

Continuous Pre Ocular Tear Film
Hydrodynamic Lubrication = Low Coefficient of Friction



Non-continuous Pre Lens Tear Film
Boundary Lubrication = High Coefficient of Friction



Repetitive Lid Margin Microtrauma

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Lid Margin Tissue Damage & Inflammation

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Contact lens Discomfort

Decreased Tear Film Homeostasis

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Conjunctival Tissue Exposure

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Conjunctival Tissue Damage & Inflammation

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Contact Lens Discomfort

TEAR KINETICS IN CONTACT LENS INDUCED DRY EYE

Michel Guillon

BCLA Medal Address – 9th May 2017