SCLERAL LENSES 10 YEARS AFTER: WHERE ARE WE?

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DISCLOSURES

DR MICHAUD

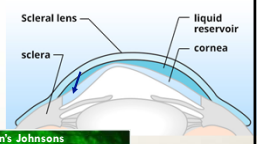
- HONORARIUM OR RESERACH FUND RECEIVED
  - BAUSCH & LOMB
  - COOPER VISION
  - VIT- NATURALEYES
  - SYNERGEYES
  - LABORATOIRES BLANCHARD

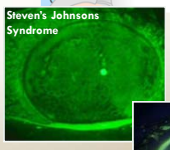
DR BRAZEAU

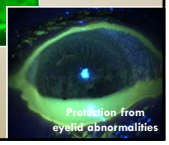
- HONORARIUM OR RESERACH FUND RECEIVED
- BLANCHARD LABS

SL ARE AMAZING

- USED AS TREATMENT FOR SEVERAL OCULAR SURFACE CONDITIONS
- CONSIDERED A REHABILITORY DEVICE FOR OCULAR SURFACE COMPROMISE (IE. DRY EYE)







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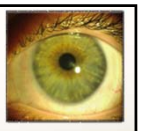
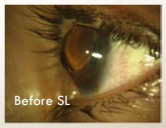
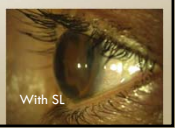
SL ARE AMAZING



- SL provide a rigid refractive surface that allows retinal image formation through distorted corneas (ie. keratoconus)
- Large optic zone = improved vision
- Stability = better centration - presbyopia





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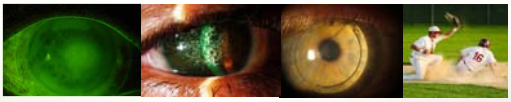
SCLERAL LENSES BENEFITS

- STABLE, PREDICTABLE VISUAL ACUITY
- IMPROVED COMFORT VS OTHER MODALITIES
- TEAR FLUID LAYER
  - MOIST MICRO-ENVIRONMENT, PROTECTIVE, REFRACTIVE
- REDUCED LENS MOVEMENT ON THE EYE
  - IMPACT ON COMFORT (LENS TO LID INTERACTION) AND OPTICS (CENTRATION)



- IRREGULAR CORNEAS
- DISEASED EYES
  - INCLUDING DRY EYE SYNDROME

Known applications

- NORMAL CORNEAS
  - PATIENTS SYMPTOMATIC OF DISCOMFORT OF FLUCTUENT VISION
  - HIGH REFRACTIVE ERRORS
  - ASTIGMATISM (UP TO 3-3.5D WITH A SPHERICAL)
  - PRESBYOPIA (ESPECIALLY WITH ASTIGMATISM)
  - SPORTS
  - ALLERGY CONTROL

New trend

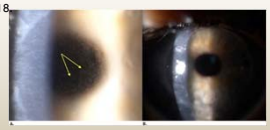
LESSONS FROM THE LAST 10 YEARS: SCLERAL LENSES LIMITATIONS

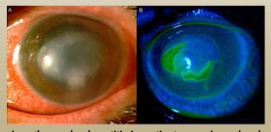
- HANDLING
  - APPLICATION AND REMOVAL
- LEARNING CURVE
  - FITTING AND TROUBLESHOOTING VS OTHER MODALITIES
- PHYSIOLOGICAL IMPACT
  - EPITHELIAL BOGGING
  - CORNEAL HYPOXIC STRESS
  - IOP (?)
- REFRACTIVE
  - HOAS
  - HIGH REFRACTIVE ERRORS (LENS MASS AND THICKNESS)

THE SCLERAL LENS

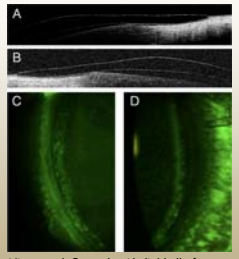
It is not without complications…

Guillon NC, Godfrey A, Hammond DS. Corneal oedema in a unilateral corneal graft patient induced by high Dk mini-scleral contact lens. CLAE 41(5). 458-62. 2018.





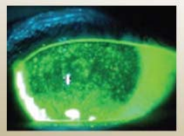
Acanthamoeba keratitis in patients wearing scleral contact lenses. Porto Sticca M. CLAE 41(3). 307-10. 2018.



Nixon et al. Corneal epithelial bull after shot-term wear of small diameter contact lenses. CLAE 40(2). 116-26. 2017.

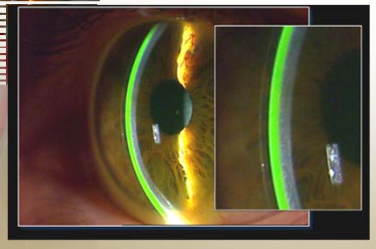
Risk / Benefits: Evaluate Options

VS



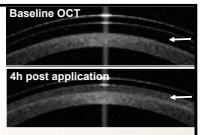
10 YEARS AFTER :
MID-DAY FOGGING, STILL NO.1 ISSUE

ISSUE # 1: MID-DAY FOGGING



Credit : Dr M. Walker

CURRENT THINKING IN MDF



- Sequestered lipids, proteins, cell fragments, make-up, mixture of all these components (variable)
- Can mostly be managed by lens fit and hygiene
- No apparent increase in inflammation

Visual frustrating!

Necessitates removal and refreshing of solution 2-5+ times per day
Most often affects people with ocular surface disease (ie. MGD)

Credit : Dr M. Walker

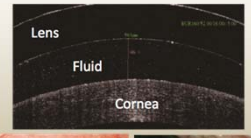
MECHANISMS OF MDF

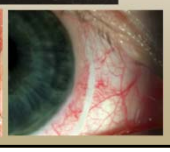
- OCULAR SURFACE DISEASES, DYSFUNCTION (IE. ALTERED INFLAMMATORY RESPONSE)
- MECHANICAL DISTURBANCE OF CONJUNCTIVAL TISSUE (IE. CHANGE IN BV PERMEABILITY)
- SCLERAL LENS SUCTION EFFECT

CURRENT THINKING IN MDF

Main Culprits:

- Central clearance – limit to 240 um (Nichols manuscript)
- Limbal clearance – lower it (<75 um)
- When to limit tear exchange, and when to enhance it?
- Lens design changes
- Diameter
- Toric peripheral curves
- Lens removal and reapplication – pros and cons

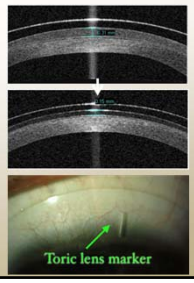




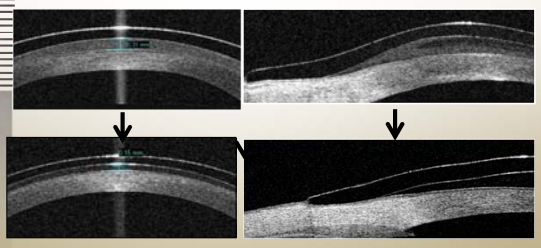
MANAGEMENT OF MDF

Primary Management Strategies:

- Reduce clearance
- Loosen/toric landing zone
- A well aligned (haptic) is the least likely to induce MDF
- Change solution…



MANAGEMENT OF MDF: LENS DESIGN



MANAGEMENT OF MDF: LENS DESIGN

- **Personal hygiene therapies (change along with fit!)**
  - Eyelid health
  - Treatment of allergies/dry eye
  - Eyewash
  - Waiting to apply lenses in AM

MANAGEMENT OF MDF: APPLICATION SOLUTION

- Preservative free artificial tears
- Autologous Serum – severe OSD

ADJUNCT THERAPIES

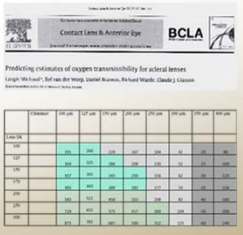
- Care regimen
- Lubrication during lens wear
- Medication in case of ocular surface disease
- Do lens coating help?

WHAT HAPPENS TO THE CORNEA ?

- EPITHELIAL LEVEL
  - OXYGEN CONSUMPTION
  - EPITHELAL BOGGING – INFLAMMATORY ?
- STROMA
  - CORNEAL SWELLING
- ENDOTHELIUM
  - BLEBS

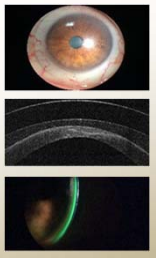
10 years after: hypoxic stress is confirmed !

- **A theoretical approach**
  - Considering available materials
    - DK of 100 to 170
  - Various lens thicknesses
    - 250-500 um
  - Post-lens tear thickness
    - 100-400 um
- **PREDICTED OUTCOME:**



AVERAGE SCLERAL LENSES

- TRADITIONAL CT
  - .3MM THICK (300 MICRONS) TO .6MM THICK (600 MICRONS)
    - RANGES GREATLY BASED ON RX
    - INDUSTRY CONCERN OF FLEXURE UNDER .3MM
    - AVERAGE CT = .45MM
- TRADITIONAL VAULTS
  - MULTIPLE FITTING SETS AND LECTURES REVIEWED
    - LOW VAULT = 100 MICRONS
    - HIGH VAULT = 600 MICRONS
    - AVERAGE = 300
- TRADITIONAL MATERIAL
  - LAGADO TYRO 97 = DK 97
  - BOSTON XO = DK 100
  - CONTAMAC OPTIMUM EXTRA = DK 100
    - AVERAGE DK OF 100
    - TYPICALLY BETTER WETTING ANGLES
- TRADITIONAL HAPTICS
  - NO BLANCHING OF CONJUNCTIVAL VASCULATURE
    - VARIED BASED ON GUIDE
      - SOME STATE QUADRANT OF BLANCHING OK
- DK/T = 12



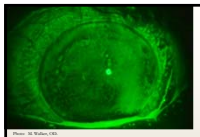
AN IN VIVO STUDY

Oxygen Tension Beneath Scleral Lenses of Different Clearances

- ** RELATIVE PO_2 AT CORNEAL SURFACE EXPECTED FROM THESE DK/T WERE ESTIMATED AS FOLLOWS:
  - EOP (%) = -19.6 * EXP (-0.029 * DK/T) + 19.8 (R^2 = 0.97)
- MINIMAL LEVEL TO AVOID HYPOXIA = 9.9%
- CALCULATED VALUES OF DK/T WERE INPUT INTO THIS EQUATION

	SL 200	SL400	*p*
Average clearance (um) (SD)	**239.7± 34.7**	**434.5 ± 33.2**	< 0.05
Average lens thickness (um) (SD)	315.1 ± 0.7	309.5 ± 1.3	> 0.05
Estimated DK/t (x 10^{-9}) (cm/sec)(ml O_2/ml X mmHg)	19.1±1.6	13.0± 0.7	
Predicted pO_2 (%) **	8.52± 0.51	6.37± 0.28	
Measured pO_2 (%) (SEM)	9.07 ± 0.86	6.19 ± 0.87	< 0.05

*Benjamin, W.J and RM Hill, Human cornea: individual responses to hypoxic environments. *Graefes Arch Clin Exp Ophthalmol*, 1988. 226(1): p. 45-8.



Epithelial bogging

- **Epithelial bogging or "Water-logged epithelium" occurs when cornea is in saline for 10-12 hrs/day**
  - Similar to skin wrinkling when put in water for extensive period of time
  - Electrolyte imbalance or altered homeostasis stimulates sympathetic nerve response

- **In response: cells are swelling /Increase their surface**
  - Slight adaptation, bogging reduction, can happen over weeks/months
- **Troubleshooting**
  - Artificial tears with electrolytes /SH
  - Increase tear exchange (flatter pc's) and oxygen delivery
  - Hyperosmotic agent – short term ; cyclosporine – long term

HYPOXIC STRESS

Identification of Leukocytes Associated With Midday Fogging in the Post-Lens Tear Film of Scleral Contact Lens Wearers

- HYPOXIC ENVIRONMENT CAN INDUCE LEUKOCYTE INFILTRATION
- OXYGEN TENSION AT CORNEAL LEVEL, DURING SLEEP = 2-4% VS 21% OPEN-EYE
- SAME LEVEL OF OXYGEN TENSION UNDER A SCLERAL LENS
- THEREFORE THE HYPOXIC ENVIRONMENT UNDER A SCCL SOMEWHAT MIMICS THE CLOSED EYE ENVIRONMENT AND LEAD TO LEUKOCYTE INFILTRATION = FOGGING

CLINICAL IMPACT

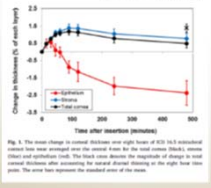
Identification of Leukocytes Associated With Midday Fogging in the Post-Lens Tear Film of Scleral Contact Lens Wearers

This study also showed that central ScCL clearance was also significantly associated with the presence of post-lens tear film fogging. In particular, for every 50-µm increase in ScCL central clearance, there was a 2.24 times higher odds of presenting with post-lens tear film fogging. This finding supports the recommendation of minimizing corneal clearance, sometimes recommended to be less than 200 µm.[3]

TIME COURSE

Contact Lens and Anterior Eye

The time course and nature of corneal oedema during sealed mini-scleral contact lens wear



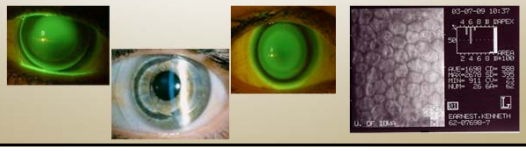
Conclusions: Scleral lens induced corneal oedema is stromal in nature. On average, central stromal and total corneal thickness increased rapidly following lens insertion and peaked after 90 min, while central epithelial thickness gradually decreased throughout lens wear consistent with natural diurnal variation. A greater initial central corneal clearance resulted in reduced oxygen delivery to the cornea, which had minimal short-term impact upon healthy eyes, however, minimising central corneal clearance may be important in eyes with reduced endothelial cell function to minimise hypoxic stress.

SCLERAL LENS AND ENDOTHELIAL CELLS

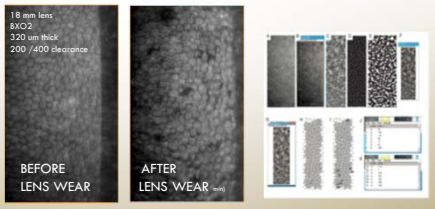
"ENDOTHELIAL CELL COUNT OF LESS THAN 800 CELLS/MM2 IS WHERE THE PROBLEMS MAY ARISE (SINDT 2010A), AND ENDOTHELIAL CELL COUNTS <1,000 CELLS/MM2 SHOULD BE HANDLED WITH EXTRA CARE AND SHOULD NOT BE FITTED WITH SCLERAL LENSES TO AVOID EDEMA."

EEF VAN DER WORP, 2015. A GUIDE TO SCLERAL LENS FITTING (2 ED.)

EXHAUST OTHER OPTIONS FIRST:



A NEW FINDING: BLEBS !!!



OTHER CONTRIBUTING MECHANISMS ?

- TEAR EXCHANGE
  - MINIMAL DURING LENS SETTLING
  - PAUGH, EYE & CONTACT LENS: MARCH 2018 - VOLUME 44 - ISSUE 2 - P 97–101
    - 0-30 MIN 0.57 (±0.6) %/MIN
    - 30-60 MIN 0.42 (±0.5) %/MIN
    - NON-CL WEAR 34.17 (±15.9) %/MIN
    - SI-HY CL (0-30) 6.09 (±2.8) %/MIN.
- TEAR MIXING (MENG LIN, GSLS 2018)
  - NOT CONTRIBUTING A LOT
  - IMPROVED IF CLEARANCE IS REDUCED

IMPACT ON THE SELECTION OF THE LENSES

- **THERE ARE OPTIONS TO ALLEVIATE HYPOXIA**
  - TO FIT LENSES WITH REDUCED THICKNESS
  - TO LIMIT FLUID LAYER THICKNESS (CLEARANCE) WHENEVER POSSIBLE
  - TO MODULATE SCLERAL LENS WEAR BASED ON INDIVIDUAL CORNEAL CHARACTERISTICS

Most probably feasible with smaller diameter scleral lenses
OR
Customized larger scleral lenses

… all manufatured with highest DK material

10 YEARS LATER: NEW FINDINGS

VISUAL QUALITY AND SCLERALS

RESIDUAL ASTIGMATISM : KC AND GPS

- 76 EYES WITH PARACENTRAL CONES / 80 CENTRAL CONES
- SUBJECTS: 22.1 YEARS OLD
- -3.50 ± 1.62D REFRACTIVE ASTIGMATISM
- FITTED WITH 3 POINT TOUCH APPROACH GP LENSES
- RESIDUAL ASTIGMATISM : - 0.75D ± 0.37
- NO EFFECT FROM THE CONE LOCATION (CENTRAL OR PARACENTRAL)

Cont Lens Anterior Eye. 2012 Feb;35(1):17-21. doi: 10.1016/j.clae.2011.08.007. Epub 2011 Sep 14.
Cone location and correction of keratoconus with rigid gas-permeable contact lenses.
Nejabat M[1], Khalili MR, Dehghani C.

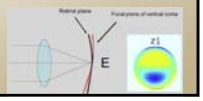
MOST LIKELY COMING FROM HOA !!!

- KC PATIENTS SHOW REDUCED CORRECTED VISION VS NORMAL POPULATION
- THIS MAY BE ATTRIBUTED TO THE PRESENCE OF HOA
- CORRECTION OF HOA UP TO 6TH ORDER OF ZERNIKE RESTORE VA IN KC PATIENTS
- REDUCED VA IN GP FITTED KC PATIENTS RESULT FROM UNCORRECTED HOA

Optom Vis Sci. 2007 Jun;84(6):463-70.
Uncorrected wavefront error and visual performance during RGP wear in keratoconus.
Marsack JD, Parker KE, Pesudovs K, Donnelly WJ 3rd, Applegate RA.

HOA AND POSTERIOR CORNEAL SURFACE

- 24 NORMAL VS 28 KC EYES
- HOA EVALUATED WITH SCHEIMPFLUG ON BOTH CORNEAL SURFACES
- TOTAL HOA ANT/POST： 4.34 / 1.09 KC 0.46/0.15 CONTROL
- HOA IN KC: COMA > TREFOIL > NEGATIVE SA
- ANTERIOR SURFACE COMPENSATES IN PART FOR POSTERIOR SURFACE HOA
- RESIDUAL ASTIGMATISM IN PATIENTS WITH KC WEARING RIGID GAS PERMEABLE LENSES CAN BE ESTIMATED BY MEASURING HOA FROM THE POSTERIOR CORNEA



Invest Ophthalmol Vis Sci. 2009 Jun;50(6):2660-5. doi: 10.1167/iovs.08-2754. Epub 2008 Nov 21.
Higher-order aberrations due to the posterior corneal surface in patients with keratoconus.
Nakagawa T, Maeda N, Kosaki R, Hori Y, Inoue T, Saika M, Mihashi T, Fujikado T, Tano Y.

OBLATE DESIGN MAY HELP

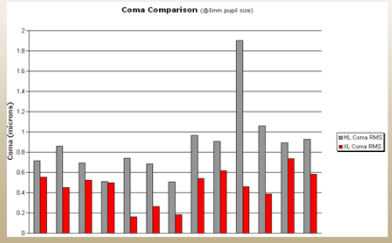
Kuzy et al . Ohio state Study

Use of small RGP reverse geometry Vs regular design on KC patients

Significant reduction of coma

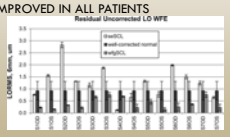
Significant improvement of VA

Significant reduction of minus power

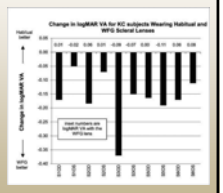


SCLERAL LENSES : SIMILAR FINDINGS

- HOA NOT TOTALLY COMPENSATED WITH REGULAR SCLERAL LENSES
- WAVE-FRONT GUIDED DESIGNED LENSES REDUCE HOA SIGNIFICANTLY
- CONSEQUENTLY, VA IS IMPROVED IN ALL PATIENTS

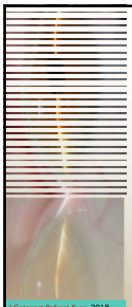


Mean uncorrected higher-order RMS measured over a 6 mm pupil while wearing the spherical equivalent scleral contact lens (light gray bars) and wfgSCL(gray bars). Age-matched higher-order RMS from Applegate et al. is also presented (dark gray bars).

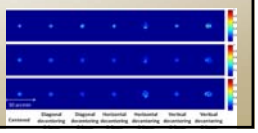


Optom Vis Sci. 2014 Oct;91(10):1221-30.
Wavefront-guided scleral lens correction in keratoconus.
Marsack JD, Ravikumar A, Nguyen C, Ticak A, Koenig DE, Elswick JD, Applegate RA.

HOA AND LENS CENTRATION (IOL)



- LENS CENTRATION INFLUENCES THE PRESENCE OF HOA
- 2ND ASTIGMATISM INCREASES BY 0.18 TO 0.26 UM / MM OF DECENTRATION
- COMA INCREASES BY 0.19 TO 0.39 UM /MM OF DECENTRATION
- 0.7 MM LENS DECENTRATION INCREASES STREHL RATIO X 2.2 TO 3.2 TIMES VS CENTERED LENS
- SIGNIFICANT IMPACT FROM LENS DECENTRATION
- RESULTS CAN BE EXTRAPOLATED TO CONTACT LENSES



J Cataract Refract Surg. 2018 Jul;44(7):889-896
Effect of intraocular lens decentration on image quality tested in a custom model eye.
Pérez-Merino P, Marcos S.

LENS DECENTRATION

- CAUSES:
  - LID FORCES
  - LENS MASS (EXCESSIVE CT)
  - EXCESSIVE LIMBAL CLEARANCE
  - POOR ALIGNMENT BETWEEN LANDING ZONE AND SCLERA
  - CORNEAL / SCLERAL SHAPE FACTORS

PHYSIOLOGICAL IMPACTS

- LENS BEARING ON THE NASAL SUPERIOR CORNEA
- CORNEAL STAINING
- HIGHER DISCOMFORT

THE OPTICAL IMPACT

- DECENTERED LENSES INDUCE:
  - BASE DOWN PRISM
  - COMA AND SPHERICAL ABERRATION WITH MODERATE TO LARGER PUPILS
  - DECENTRATION OF ADD ZONES WITH MULTIFOCALS
  - RESIDUAL ASTIGMATISM

UNIVERSITY OF MONTREAL

HIGH ORDER ABERRATIONS WITH AND WITHOUT SCLERAL CONTACT LENSES IN PATIENTS WITH KERATOCONUS

U de M study

Discussion
- 60% or higher reduction for high order aberrations in 29 eyes
- 31 eyes for coma and 30 eyes for trefoil
- Better improvement for those with high HOA uncorrected

Conclusion
- Scleral contact lenses greatly minimize high order aberrations in patients with keratoconus
- In some patients, HOA remains at a higher level and may disturb visual acuity
  - Sub-analysis: early cones, with better than 20/40 VA in glasses

SCLERAL LENSES: RESIDUAL ASTIGMATISM

Suggested etiologies

- Lens flexure
- Tear layer profile - Lens decentration
- Lenticular astigmatism
- High corneal astigmatism
- HOA ?????

LET'S TAKE A LOOK AT LENS « FLEXURE »

- LENS FITTED WITH SMAP 3D – TORIC PC'S AS NEEDED
- VARIATION OF LENS THICKNESSES AND CLEARANCE
- DEMOGRAPHICS: F (70%) M (30%); 23 Y.O.; NON SCLERAL LENS WEARERS, WASHOUT 72H00

	LENS A and C (OD)	LENS B and D (OS)
Refraction sphere	-1.88 ± 1.59	-1.72 ± 1.70
Refraction CYL	-0.45 ± 0.29	-0.54 ± 0.31
BCVA @ distance (baseline)	-0.14 ± 0.09	-0.15 ± 0.09
Flat K	43.65 ± 1.39	43.27 ± 1.55

Measured	LENS A	LENS B	LENS C	LENS D
Thickness	347.3 ± 16.3	350,45 ± 10.8	266.8 ± 16.5	260.0 ± 10.9
Clearance	98. 2 ± 70.1	226.3 ± 60.6	96.1 ± 70.1	240.6 ± 60.1
Power	-0.25	Plano	-0.25	Plano

INDUCED ASTIGMATISM

Over-ref	LENS A Thick /Low clear.	LENS B Thick/ High clear	LENS C Thin /Low clear	LENS D Thin / High clear
Sphere	-0.66 ± 1.68	-3.25 ± 2.23	-0.52 ± 1.69	-3.43 ± 2.37
Cyl	-0.50 ± 0.29	-0.75 ± 0.34	-0.65 ± 0.34	-0.66 ± 0.22
Axis	86 ± 15	93 ± 22	87 ± 18	91 ± 26
Over K	0.42 ± 0.13	0.29 ± 0.14	0.39 ± 0.18	0.35 ± 0.16
VA (SE)	0.05 ± 0.08	0.02 ± 0.05	-0.01 ± 0.04	0.06 ± 0.07

	Lens A Vs B	Lens A Vs C	Lens C vs D	Lens B vs D
Parameters (T/C)	Clearance	Thickness	Clearance	Thickness
p	0.07	0.176	1.00	0.211

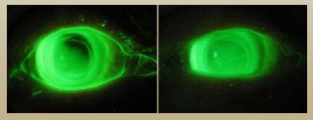
TROUBLESHOOTING

TO DO

- REEVALUATE THE FIT ONCE THE LENS IS ALLIGNED
- DESIGN PERIPHERAL CURVES IN ALL QUADRANTS (NOT ONLY THE PRINCIPAL MERIDIANS)
- REDUCE LENS MASS
- REDUCE LIMBAL CLEARANCE
- REDUCE LENS DIAMETER
- OBLATE DESIGN MAY HELP
- ..IF NOT, CONSIDER OTHER OPTIONS
- WAVE-FRONT CORRECTED OPTICS WHEN IT WILL BE AVAILABLE

NOT TO DO

- INCREASE LENS THICKNESS
- RX FRONT-TORIC LENS WITHOUT CHECKING WITH LOOSE LENS BEFORE



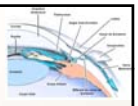
10 YEARS LATER: NEW FINDINGS

INTRA-OCULAR PRESSURE AND SCLERALS

UNDERSTANDING THE FLUID LAYER COMPONENT

- RESERVOIR IN SERIES
- VOLUME COMPRESSION
- SUB-ATMOSPHERIC PRESSURE
- INCREASED TIGHTENING OVER TIME

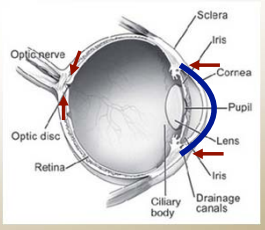
THEORETICAL ASPECTS



- MCMONNIES RAISED THE HYPOTHESIS THAT SCLERAL LENSES MAY INDUCE IOP ELEVATION DURING LENS WEAR (MCMONNIES, 2016)
  - EPISCLERAL VEINS COMPRESSION (MCMONNIES, 2016A)
  - SCHLEMM'S CANAL DEFORMATION BENEATH THE LANDING ZONE (NAU, 2016)
  - BEARING ZONES MAY APPLANATE OCULAR SURFACE
    - AREA AND DEPTH OF INDENTATION : 2ND TO DEGREE OF FITTING TIGHTNESS
      - HIGHER RISK : THINNER SCLERA (MCMONNIES, 2017); SMOOTHER SCLERA (NAU, 2016); SMALLER LENSES (NAU 2016)
    - AREA AND PRESSURE APPLIED ARE THE KEY FACTORS, NOT RIGIDITY (PAULA, 2016)

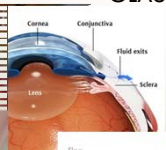
IS GLAUCOMA A RELATIVE CONTRAINDICATION TO SL WEAR?? THEORETICAL ASPECT

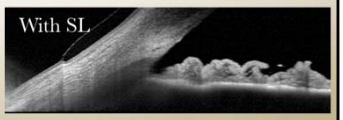
Compressive landing zone on the conjunctiva



Courtesy: M. Walker

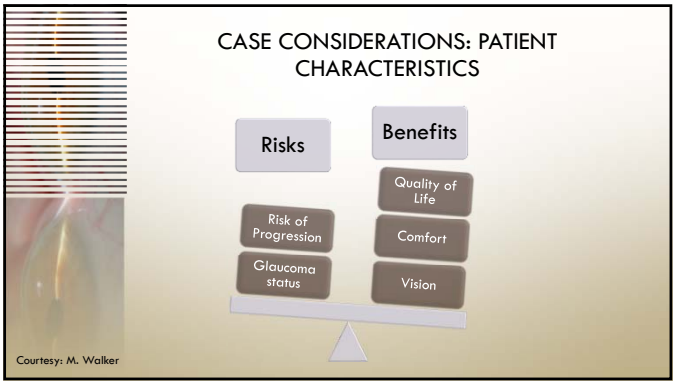
GLAUCOMA PATIENTS WITH A/C SURGERIES





Courtesy: M. Walker

CASE CONSIDERATIONS: PATIENT CHARACTERISTICS



RESULTS

IOP VS TIME AND DIAMETER

- IOPG:
  - NO DIURNAL VARIATION

	L1 (15.8mm)	L2 (18.0 mm)
No variation	4 (19%)	1 (4%)
> 10 mm Hg	4 (19%)	3 (14%)
Average	5 mm Hg	5 mm Hg
Highest	+15 mm Hg	+17 mm Hg

CORNEAL CHANGES

- BACK SURFACE K READINGS (CENTRAL)
  - NO VARIATION DURING LENS WEAR
- FRONT SURFACE K READINGS
  - NO SIGNIFICANT VARIATION
  - SLIGHT FLATTENING- SUPERIOR QUADRANT

DISCUSSION

*Corneal Edema and Scleral Lenses**

DAVID MILLER AND JOHN M. CARROLL

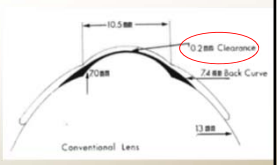
- MILLER AND CAROLL FOUND A SUB-ATMOSPHERIC PRESSURE OF 5 TO 18 MM HG

Cling

In scleral lens fitting, the force necessary to pull a lens from the eye is known as *lens cling*. Ridley [8] noted that a high degree of cling was related to the early development of epithelial edema. Recently we have been able to quantify cling by using a suction cup attached to a gram gauge (Fig. 6). In taking such a measurement, the suction cup is firmly affixed to the lens and the force needed to just pull the lens from the eye is recorded. This force is a reflection of the combined effect of surface tension and a negative pressure which developed behind the lens. Minimal cling in a well-fitted scleral lens averages 25 grams, whereas tight-fitting lenses require forces of from 75 to 200 grams for removal. A force of 75 to 200 grams suggests the presence of a negative pressure behind the lens of from 5 to 18 mm. Hg.

CLINICAL OUTCOME

- + LIMITED TEAR EXCHANGE
- + LENS COMPRESSION ON THE CONJUNCTIVA
- = NET SUCTION EFFECT
- = INCREASED TIGHTENING
  - MORE PRESENT WITH QUADRANT SPECIFIC TORIC HAPTICS
- = INCREASED IOP



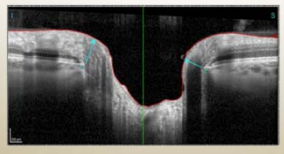
Recommended clearance of 200 um, with larger lenses … in 1968

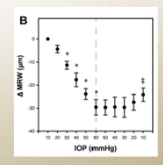
DISCUSSION

- IOP VARIED BUT CORNEA WAS KEPT THE SAME
- LENS DIAMETER DOES NOT INFLUENCE THE OUTCOME
  - SCLERA IS STIFFER CLOSER TO THE LIMBUS (ELSHEIKH ET AL., 2010)
  - PRIMARY FUNCTIONNAL DIAMETER (PFD)
    - WHERE THE LENS LANDS !
    - IN OUR STUDY PFD = 13.8 (15.8 OAD) AND 14.4 (18.0 OAD)
  - THERE IS NO SNOWSHOE EFFECT
    - CONTRADICTS NAU'S HYPOTHESIS ABOUT SMALLER LENSES AS A RISK FACTOR
    - BOTH LENSES COMPRESS THE CONJUNCTIVA IN THE SAME AREA

ANOTHER WAY OF EVALUATION IOP VARIATION EFFECT

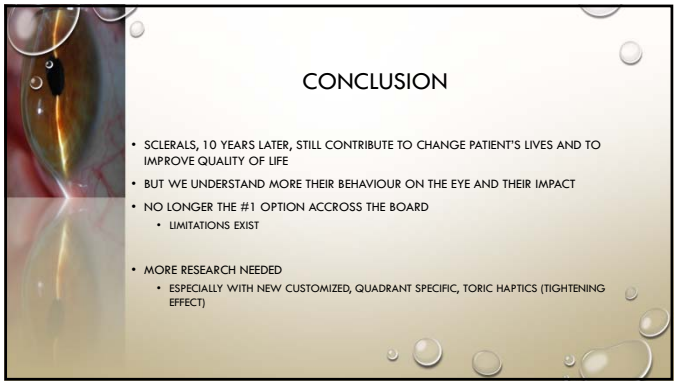
- BRUCH'S MEMBRANE OPENING (BMO): TERMINATION OF BRUCH'S MEMBRANE AT THE OPTIC NERVE HEAD
- MINIMUM RIM WIDTH (MRW): SHORTED DISTANCE FROM THE BMO TO THE INNER LIMITING LAMINA (ALSO TERMED BMO-MRW)





Courtesy: M. Walker


IMPACT ON LENS DESIGN
• SMALLER VS LARGER DIAMETER
• ALLEVIATE HYPOXIA
• NO IMPACT ON IOP
• TORIC HAPTICS NEEDED
• TO LIMIT LENS TIGHTENING EFFECT
• MATERIAL SELECTION
• HIGHER DK AVAILABLE
• TEAR EXCHANGE
• IF POSSIBLE
• VS DEBRIS


CONCLUSION
• SCLERALS, 10 YEARS LATER, STILL CONTRIBUTE TO CHANGE PATIENT'S LIVES AND TO IMPROVE QUALITY OF LIFE
• BUT WE UNDERSTAND MORE THEIR BEHAVIOUR ON THE EYE AND THEIR IMPACT
• NO LONGER THE #1 OPTION ACCROSS THE BOARD
• LIMITATIONS EXIST
• MORE RESEARCH NEEDED
• ESPECIALLY WITH NEW CUSTOMIZED, QUADRANT SPECIFIC, TORIC HAPTICS (TIGHTENING EFFECT)