



ADULT STRABISMUS

CASE STUDIES 4

CATARACT SURGERY AND DIPLOPIA

Lionel Kowal
RVEEH



WHY DOES MY PATIENT SUDDENLY SEE DOUBLE AFTER CATARACT OPERATION ?

OVERVIEW OF FACTORS CAUSING DIPLOPIA IN CATARACT PATIENTS

Lionel Kowal RVEEH

תננו מאתך דעה בינה והשכל

DISTORTIONS

- Everything in my talk is distorted by selection bias
- I don't do cataract surgery. I don't see the numerous happy pts that you see ... I see a small Array of pts with imperfect outcomes referred for an n-th opinion



DIPLOPIA AFTER CATARACT SURGERY

'Old' reasons	'New' reasons : Normal or near-normal muscle function: usually ≥ 1 'minor' stresses on sensory & motor fusion
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Other muscles damaged by Marcaine	Metamorphopsia 2ary to macular disease
Incidental 4ths and occult Graves' Ophthalmopathy uncovered by cataract surgery	Minor acquired motility changes of the elderly: Sagging eye muscles
<u>Rare & largely forgotten</u> Amblyopia: fixation switch Hiemann Bielschowsky	Other sensory issues: Big difference in contrast between images, large field defects.



'OLD' REASONS : -CAINE TOXICITY

CAN BE ANY MUSCLE, USU IR, ESP. LIR

- Day 1: LIR paresis : left hyper, restricted L depression, diplopia : everyone **anxious** $\leq 1\%$
 - Day 7-10: diplopia goes : everyone **happy**
 - Week 2+: LIR fibrosis begins - diplopia returns : left hypo, restricted L elevation: everyone **upset 0.1-0.2%**
 - Hardly ever gets better
-
- Spontaneous recovery from inferior rectus contracture (consecutive hypotropia) following local anesthetic injury.

Sutherland S, Kowal L. RVEEH.

Binocul Vis Strabismus Q. 2003;18(2):99-100.



SEMINAL ARTICLE

PERSISTENT VERTICAL BINOCULAR DIPLOPIA AFTER CATARACT SURGERY

D. A. JOHNSON

AM J OPHTHAL 12/2001

- Typical combination for retrobulbar block

2.2 ml 2% mepivacaine, 3.8 ml 0.75% bupivacaine, 0.25 ml 1.0% epinephrine, 150 U hyaluronidase. Total 6.25 ml

- **3-fold greater number of L c.f. R eyes** ($p < .005$).
- Insignificant ($p > 0.2$) increase with hyaluronidase shortage.

Category	Total number	<u>Diplopia</u> Number	<u>Diplopia</u> %, fraction
All eyes	17,531	32	0.18, 1/555
Topical	3,817	0	0
<u>Retrobulbar</u>			
All	13,714	32	0.23%, 1/430
One surgeon	7,410	0	0
Other R/B	6,304	32	0.51%,



MARCAINE TOXICITY AVOIDANCE

- If you add an EMG monitor to your injecting needle, whether you think you are doing a R/B or P/Bulbar, you are IN the inf rectus ~50% of the time*
- **? avoid R/B & P/B blocks if your problem rate is >0.1%**

*Elsas, Scott



MARCAINE TOXICITY

TREATMENT OPTIONS

- Prisms : Δ s often effective (often small angles)
- Botox: might work [Scott says 50%!]; my n=0
- Surgery : esp if $\geq 10\Delta$
- LK: topical, adjust on-the-table, ceiling target for diplopia, non-absorbable suture
- High success rate
- LK: Surgery 'n': used to be 1-2 a year, recently <1 a year.



MARCAINE TOXICITY: NEW APPLICATION

INCREASE THE STRENGTH OF AN
UNDERACTING MUSCLE

EG CONSECUTIVE XT

3% BUPIVACAINE TO MR, 5U BOTOX TO LR

- **Pharmacologic Injection Treatment of Comitant Strabismus**
- **Debert, Miller, Danh, and Alan B Scott**
- J AAPOS. 2016 Apr;20(2):106-111
- 55 cases :
- Injections of Botox [to paralyse / stretch] and 3% Bupivacaine [to shorten / strengthen] into opposing muscles



DIPLOPIA AFTER CATARACT SURGERY:

MOSTLY **SENSORY CAUSES**

'Old' reasons	'New' reasons : Normal or near-normal muscle function: usually ≥ 1 'minor' stresses on sensory & motor fusion
Inf Rectus contracture after Marcaine damage	Anisometropia, Monovision & Aniseikonia
Other muscles damaged by Marcaine	Metamorphopsia 2ary to macular disease
Incidental 4ths and occult Graves' Ophthalmopathy uncovered by cataract surgery	Other sensory issues: Big contrast differences, large field defects.
<u>Rare & largely forgotten</u> Amblyopia: fixation switch Hiemann Bielschowsky	Minor acquired motility changes of the elderly: Sagging eye muscles



SENSORY CAUSES

NEARLY **ALL** DIAGNOSABLE ON HISTORY

**ASK EVERY PATIENT WITH POST CATARACT
DIPLOPIA :**

Is the image seen by the R:

- Larger / smaller than the one seen by the L**
- Same shape as L**
- Paler / darker than L**
- Do you have double vision only with R fixation, only with L fixation,...**
[monocular diplopia, fixation switch diplopia]



MOTOR CAUSES

NEARLY **ALL** DIAGNOSABLE ON HISTORY

**ASK EVERY PATIENT WITH POST CATARACT
DIPLOPIA**

- **IR fibrosis: operated eye sees higher image, & is tilted towards nose**
- **[if vertical] Does it go away when the head is flat e.g. lying down on your back?
[Skew]**
- Tilted [torsion]
- Horizontal – see SES below
- **Final Q: Does it wobble?** Heimann
Bielschowsky, Sup Obl Myokymia, Horror Fusionis,
Oculo palatal myoclonus,...



ANISEIKONIA / ANISOMETROPIA / MACULA 3

VERY IMPORTANT Qs

- **1. How much anisometropia is it safe to 'correct' [reduce] with IOLs?**
- 2. How much anisometropia is it safe to **introduce** with IOLs in order to give monovision MV?
- 3. Can we treat aniseikonia [from, say, macular causes] by modifying IOL powers?



HIGH RISK #1: BEWARE CORRECTING / 'IMPROVING' ANISOMETROPIA

- **Spectacles compensate for most cases of aniseikonia 2° to axial anisometropia BETTER than do IOLs or corneal refractive surgery**
- Converting R: -12, L: -4 to -2 DS OU runs a **real risk of PRODUCING aniseikonia**, Abnormal Binocular Vision ABV* & permanent troublesome diplopia esp if there is a small hitherto asymptomatic & unrecognised phoria
- NO prospective studies to guide us how to handle anisometropic pts having IOLs

* *ABV: binocular blur, discomfort, diplopia - improved by closing one eye*



CASE 1: A CASE OF ANISEIKONIA DUE TO “SENSIBLE” CATARACT SURGERY

- 56 yo Dr for R phaco/IOL
- Pre-op refractions (SE)
- **R -8 D** **L -2.5 D**
- Post-op refractions (SE)
- **R +0.25 D (6/8) L -2.5 D (6/6)**

& **CONSTANT DIPLOPIA**

- PCT = XT 8 Δ , LHT 8 Δ

Presumably this was all a small asymptomatic phoria before cataract surgery



CAUGHT “KNAPPING”? *

AXIAL ANISOMETROPIA DOESN'T USU CAUSE ANEISOKONIA

- **If Axial anisometropia is converted to lenticular anisometropia, then aniseikonia is to be expected**
- Aniseikonia will impair motor & sensory fusion and predispose to diplopia [esp if there is also a hitherto trivial motor phoria]
- Axial lengths: R 29.48 mm, L 26.75 mm – **explains 6.5DS of anisometropia**
- Now has **13% R macropsia**

Likely to have been anticipated by pre-op CL testing

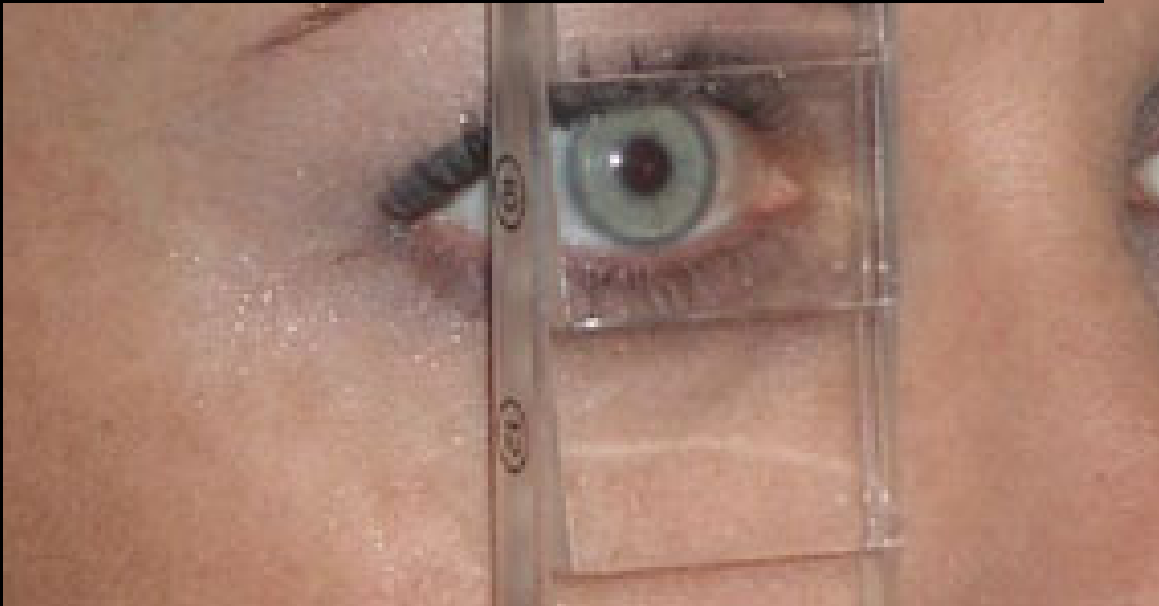
- Galilean telescope system has resolved diplopia by minimising RE image : + CL, with equivalent - to spectacle lens

**Thank you Logan Mitchell*



A SIMPLE FAIRLY ACCURATE WAY TO DETECT AND MEASURE ANISEIKONIA

- Look @ 6/60 E
- Which one is bigger? $BD\Delta R$, R sees higher image
- Does it look like an 'E' should? [metamorphopsia]
- Is the 'E' tilted? [detect torsion]
- If a bar of the 'E' is worth 20%, how much bigger is it?



Also check & confirm with BD prism in front of other eye - prisms can cause magnification



3 VERY IMPORTANT Qs

- 1. How much anisometropia is it safe to '**correct**' [reduce] with IOLs?
- **2. How much anisometropia is it safe to introduce with IOLs in order to give monovision MV?**
- 3. Can we treat aniseikonia [from, say, macular causes] by modifying IOL powers?



SURGICAL / PERMANENT MV ≠ INTERMITTENT / TEMPORARY MV 1

- Temporary: 3 month MV [e.g. early PRK days] : rare minor deficit in binocularity
- Lasik MV → reduced binocular vision in 20%

Kowal L, De Faber J, Calcutt C, Fawcett S. 'Refractive surgery and strabismus' (Workshop in 'Progress in Strabismology').

In: de Faber JT, ed. Proceedings of the 9th Meeting of the International Strabismological Association, Sydney, Australia.



SURGICAL / PERMANENT MV ≠ INTERMITTENT / TEMPORARY MV 2

- **3 patients with Pseudophakic MV IOLs who developed ET with diplopia ≥ 2 y after IOLs**

- **Rx:** Reverse the MV worked in all

Pollard et al Am J Ophthal 2011

This paper also contained examples of CL MV causing diplopia

November 2016 update from Pollard

About 50% of the pts present 2+ yrs after IOL MV

About 50% are fixed by reversing the MV [usu with glasses] -



HOW MUCH ANISOMETROPIA IS IT SAFE TO:

1. REDUCE?

2. INTRODUCE ?

○ **1. Evidence based:**

Reduce: no evidence

Introduce: Refractive surgery cohort: **1.8 DS too much**. ~20% will have symptoms of abn binocular vision [diplopia / blur/ discomfort fixed by closing one eye]

No universally accepted criteria for IOL-MV.

Common: Full distance Rx to dominant eye. [Dominant?: hole- in- card to VEP].

Some 'cross MV' – opposite approach. Some ignore dominance.

Anisometropia 1 to 2.5 DS



HOW MUCH ANISOMETROPIA IS IT SAFE TO:

1. REDUCE?

2. INTRODUCE ?

- **2. Eminence based:** ..introduce / reduce as little as possible.
- Every time you do reduce or introduce anisometropia you have a lot of evidence of pt satisfaction

BUT

- there is **an unknown [?] low % of problem patients, and the % probably increases with time after surgery.**

Increases with time:

- ?progressive deterioration of fusion because of the MV
- ?new aging changes that further damage fusion



3 VERY IMPORTANT Qs

- 1. How much anisometropia is it safe to '**correct**' [reduce] with IOLs?
- 2. How much anisometropia is it safe to **introduce** with IOLs in order to give monovision MV?
- 3. **Can we treat aniseikonia** [from, say, macular causes] **by modifying IOL powers?**



CASE 2: 65 YO MECHANICAL ENGINEER! COMPETITION TABLE TENNIS. ~25% MICROPSIA FOLLOWING RETINAL DETACHMENT SURGERY : CATARACT SURGERY PROPOSED

- 2yrs ago noticed transient vertical diplopia after prolonged near work
- 6 mo ago: **R retinal detachment.**
- VA **R 20/200. -2 : 20/125. Dense nuclear cataract.** Potential acuity [Haag Streit retinometer] 20/35.
- VA **L +1.25 20/30.**
- He estimates **~25% R micropsia.** The most I can measure with Size lenses is 13%, and he estimates an extra 10%.
- **R macular membrane**... some corrugations resemble choroidal folds.
- For distance [20/400 E]: **crossed diplopia of 4[^]; @ ~1m he has crossed diplopia 1[^].**
- Within 0.5m & with near glasses **he has weak sensory fusion** fuses a polarised 4 dot test [Brian Arthur's], Fly and 1/9 Titmus circles.

Blurred vision, anisometropia and large retinal aniseikonia: a usually trivial exodeviation of 1-4[^] is now symptomatic.

The retinal aniseikonia is not expected to go away



10 M



GOOD LEFT
EYE

RIGHT (BLURR & SMALLER)
EYE

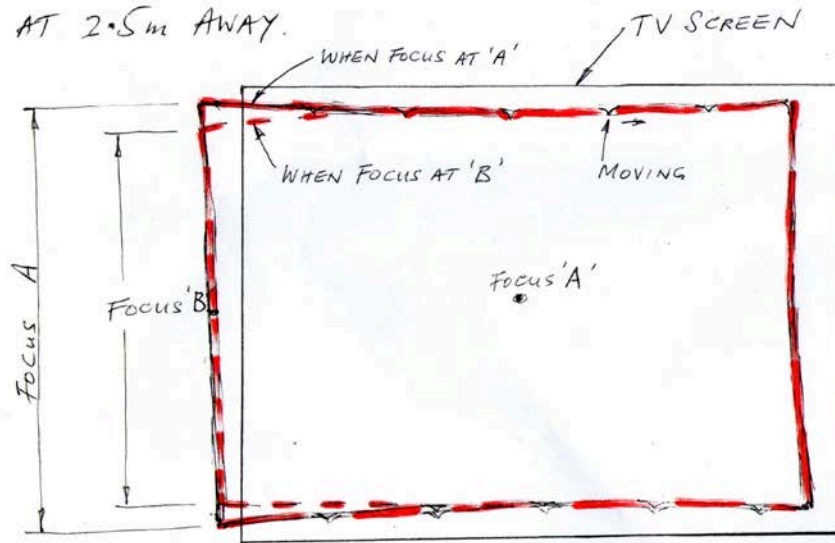
FERN LEAF
10 m. AWAY



2.5M

1st JAN 2012

TV SCREEN 420 V x 550 H
AT 2.5m AWAY.

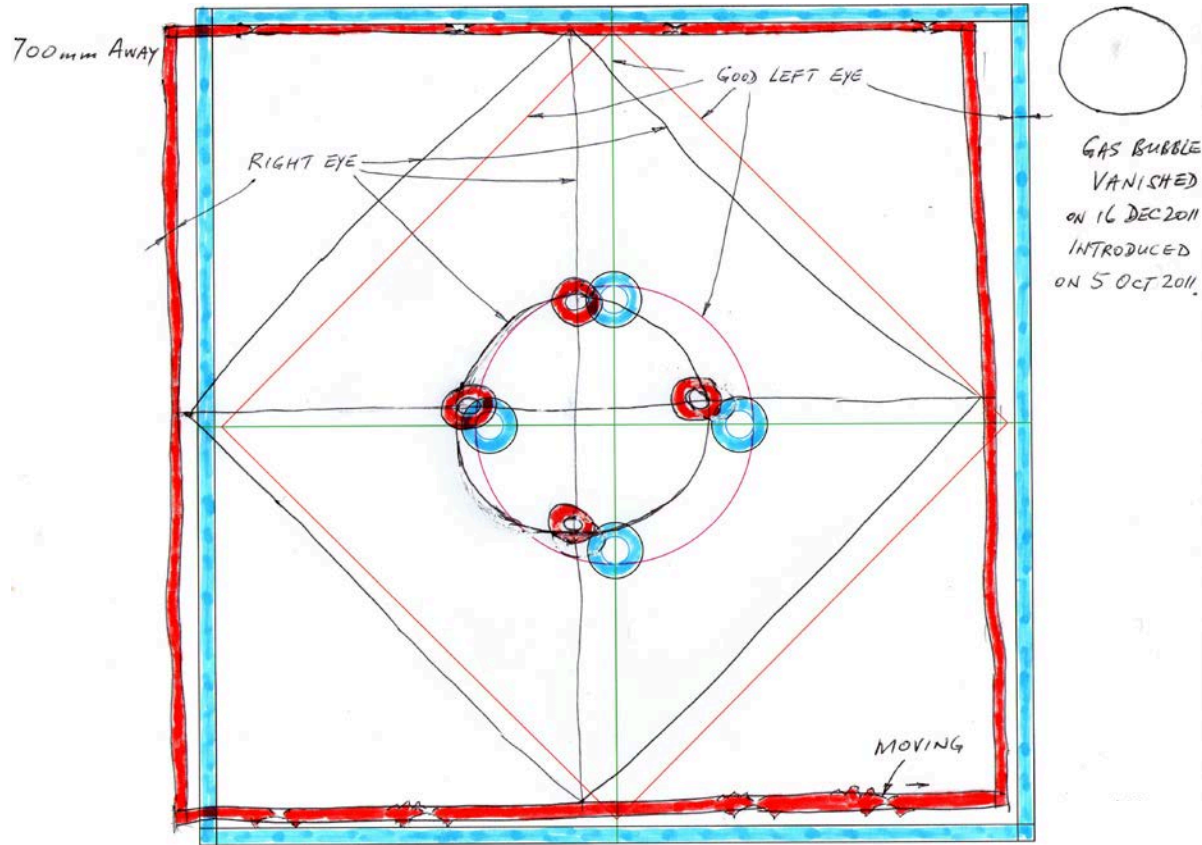


RIGHT EYE VISION **(IN RED)**

- LINES ILL DEFINED.
- LINE BECOMES SHORTER WHEN FOCUS ON OR MOVES TO.
- COLOUR IS OKAY.



0.7M



OPINION FROM 'THE' WORLD ANISEIKONIA GURU NB: HE IS A PHYSICIST – DOESN'T TREAT PATIENTS

HOW TO RESOLVE RETINAL ANISOKONIA WITH CHOICE OF IOL POWER & SPECTACLE LENS **DeWIT**

- Combining the large amount of 25% and the retinal detachment, the aniseikonia/micropsia is most likely field dependent, i.e. it varies across the retina and at larger angles in general the aniseikonia seems to be less.

Detailed explanation of how to
compensate for his aniseikonia

corrected. The patient should therefore not expect to regain a similar comfort in binocular vision as before the retinal detachment. This being said, there are patients that do benefit from having a certain amount of aniseikonia being corrected. The 25% cannot realistically be corrected, but this 25% is probably only totally in the center of vision at very small field angles



HOW TO THEORETICALLY RESOLVE RETINAL ANISEIKONIA WITH CHOICE OF IOL POWER

IOL refraction aim

- +1.25 in spectacle plane: 6% aniseikonia correction
- +3 in spectacle plane: 10% aniseikonia correction
- **An IOL power that leaves +4.75 to be corrected in the spectacle plane: 14% aniseikonia correction**
- ***Intellectually elegant workup was ignored by the cataract surgeon, left him emmetropicwith a great outcome!***
- **4y later: 6/6 sc OU. No aniseikonia. Some metamorphopsia when tested monocularly. Resumed table tennis**



HIGH RISK #2 :

BEWARE MACULAR MEMBRANES

- Metamorphopsia / aniseikonia can be beyond the ability of optical devices to resolve in some pts
- Cataract surgery can cause permanent diplopia in some of these pts
- Metamorphopsia / aniseikonia that is intolerable in some pts causes no problems in others



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CASE 3: DIPLOPIA FOLLOWING "ROUTINE" CATARACT SURGERY

- 70 yo F
- High myope
- H diplopia after 1st cataract surgery
- 'It's because of the imbalance - will be better after 2nd eye is done'



2ND EYE CATARACT SURGERY 1W LATER

- Diplopia same...2nd image now clearer.
- Symptoms dismissed [again] 'It'll get better'
- 2nd ophthalmologist: ..you're 6/6 OU...looks great



CASE 3: HEMIANOPIA

- If it's bad enough to cause loss of fusion = retinal slip, field loss won't be subtle and will be detectable on confrontation to movement of or counting fingers, losing $\frac{1}{2}$ a vision chart
- ...large pituitary tumour removed a few weeks later*



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CASE 4: SMALL VERTICALS: A NEWLY RECOGNISED MECHANISM FOR DIPLOPIA IN THE ELDERLY: SAGGING EYE MUSCLES

- 82 y o Intermittent Horizontal diplopia, mainly on left gaze, since cataract surgery 4 yrs ago
- R 6/9, L 6/6

Horizontal Deviation:

0 0
0 ← 6ET → 12ET looks like partial L 6th
 6ET

Small L hypo in primary

- Prescribed glasses:
8Δ BO, 2Δ BU LE → single vision





Restricted depression on L aBduction

SAGGING EYE SYNDROME

Image size: 512 x 512
View size: 1141 x 635
WL: 355 WW: 710
X: 165 px Y: 368 px Value: 372.00
X: -44.11 mm Y: -69.73 mm Z: -65.18 mm

072571 (83 y , 83 y)
Orbits - Exclude Patholo - Cor T1 (Thin)
27408
8

some atrophy of
LSR - LLR band

'better' SR - LR
band

Sagging of LLR :
LLR vector now
different:
ET +/- small hypo with
diplopia

Zoom: 270% Angle: 0
Im: 5/24 A (A -> P)
Uncompressed

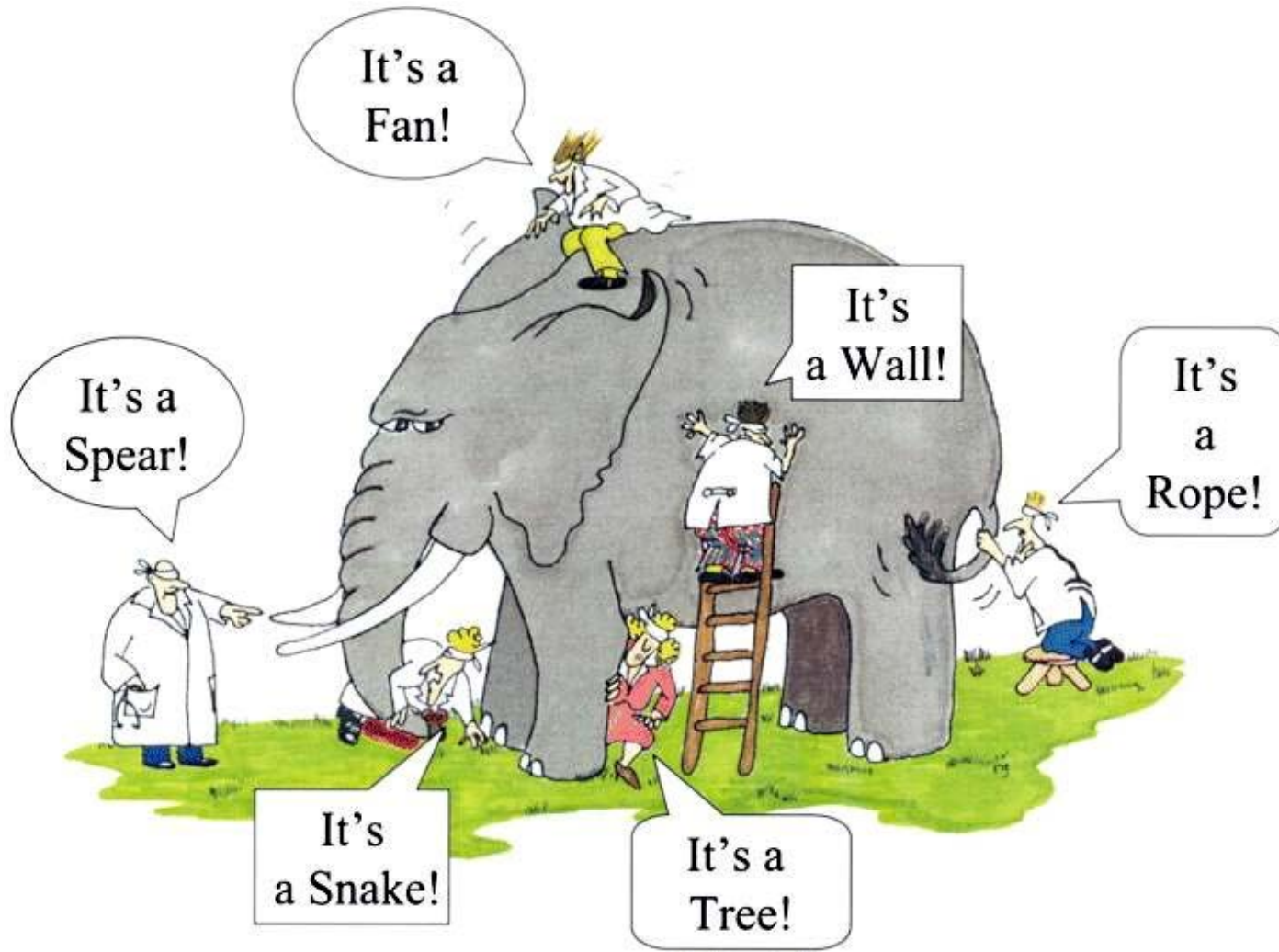
TE: 14.512 TR: 440
FS: 1.5
7/03/11 3:23:58 PM

Not directly related to cataract surgery, but happens in same age group and will be attributed by patients to cataract surgery

PS: not rare, but few radiologists know about it

SAGGING EYE MUSCLES **SES** & PROSTAGLANDIN ASSOC PERIORBITOPATHY **PAP**

○ **PAP IS PROBABLY A CAUSE OF SES**



Some descriptions of PAP include diplopia: Are these cases of SES?

THE BLIND MEN & THE ELEPHANT

DIPLOPIA AFTER CATARACT SURGERY

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AMBLYOPIA: BE CAREFUL

DO NOT PRODUCE FIXATION SWITCH DIPLOPIA

- With treated/untreated strabismus and unilateral amblyopia, there is usually a suppression scotoma in one eye.
- If the eye with the suppression scotoma is made sensorially dominant, there is no suppression scotoma available in the previously dominant eye, and if there is even a tiny strabismus, the pt may have **fixation switch diplopia**
- **Do cataract surgery on the habitually dominant eye first**



ULSTER MED J. 2013 MAY;82(2):82-4.

**CATARACT SURGERY PLANNING IN AMBLYOPIC PATIENTS--WHICH EYE FIRST?
AWARENESS OF THE POTENTIAL FOR POST-OPERATIVE DIPLOPIA AMONGST
CONSULTANT OPHTHALMIC SURGEONS IN WALES.**

SAMUEL WILLIAMS G, RADWAN M, MENON J.

- 32/42 consultants responded to the survey (>75%).
- **24/32 (75%) had encountered amblyopic patients who had developed problems after cataract surgery**
- Which eye first?
- 18 (56%): cataract surgery first on the non-amblyopic eye
- 11 (34%): amblyopic eye first
- 3 (9%): patient preference dictates the choice regarding which eye is operated first.



HIGH RISK #3

LONG STANDING MONOCULAR CATARACT

...or cataract in a pt with long standing acquired visual loss for another reason

- LOOK FOR SLOW VERTICAL OSCILLATION, typically ~1Hz
- = Heimann Bielschowsky Phenomenon
- VERY UNDER-RECOGNISED
- **All get vertical postop diplopia**

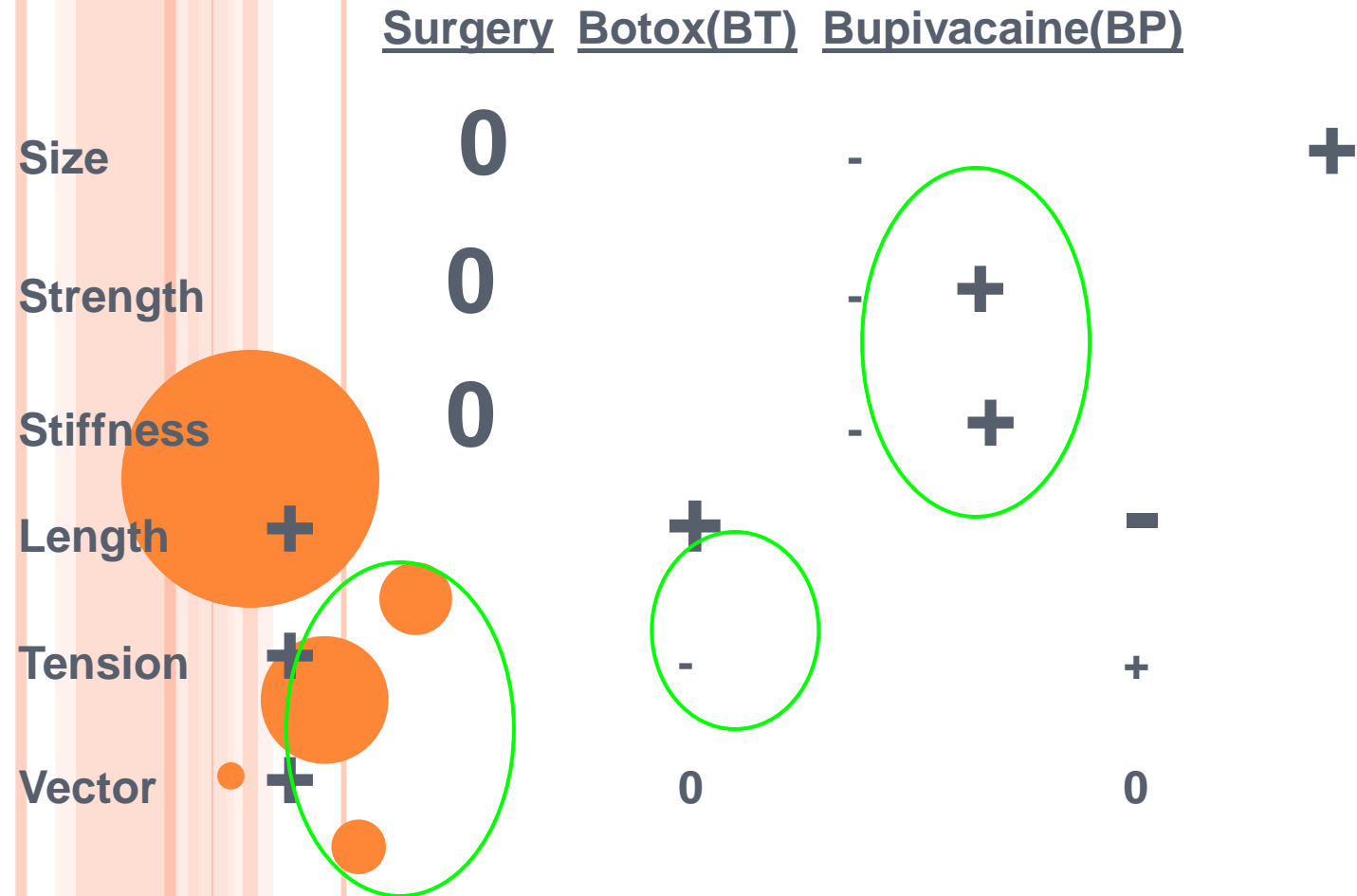
Aust N Z J Ophthalmol. 1998 Aug;26(3):237-40.

The Heimann-Bielschowsky phenomenon: dissociated vertical nystagmus.

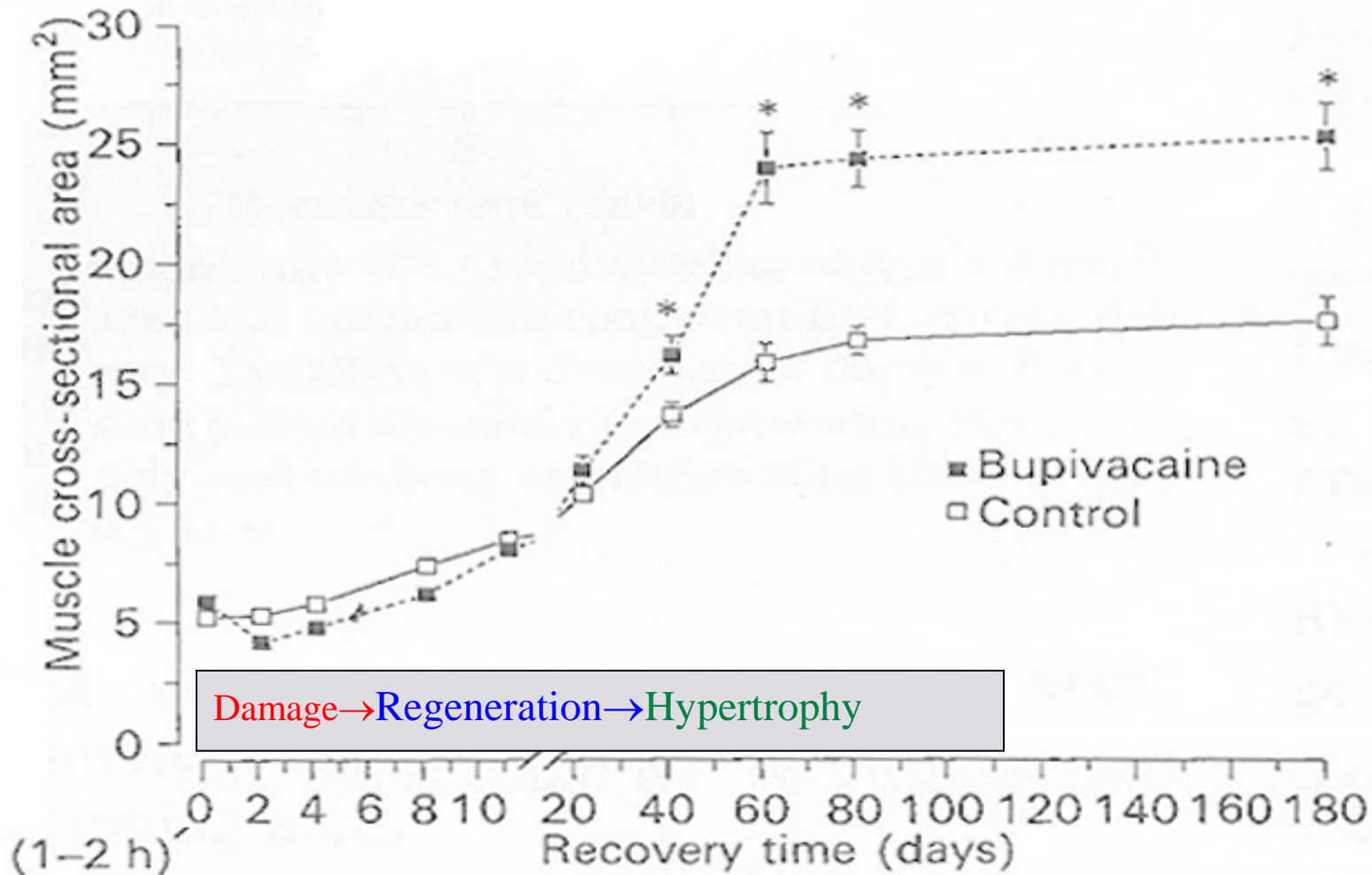
Davey K, Kowal L, Friling R, Georgievski Z, Sandbach J.



CHANGING EXTRAOCULAR MUSCLE (EOM) BIOMECHANICAL PROPERTIES



BP injection in animals:



Damage → Regeneration → Hypertrophy

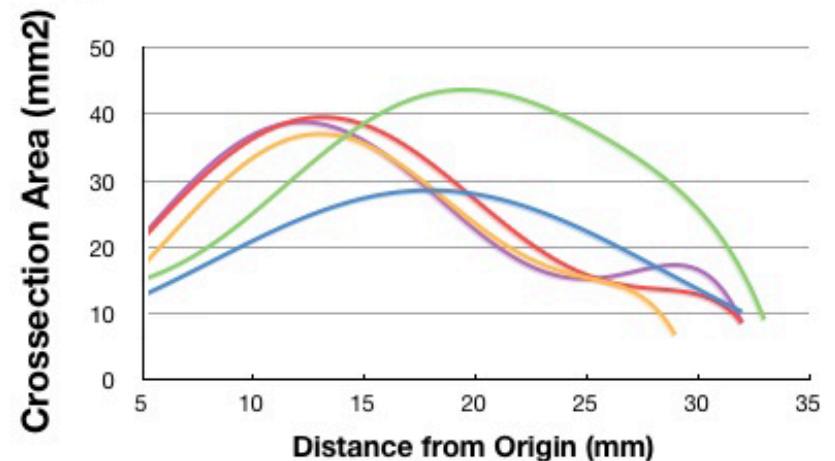
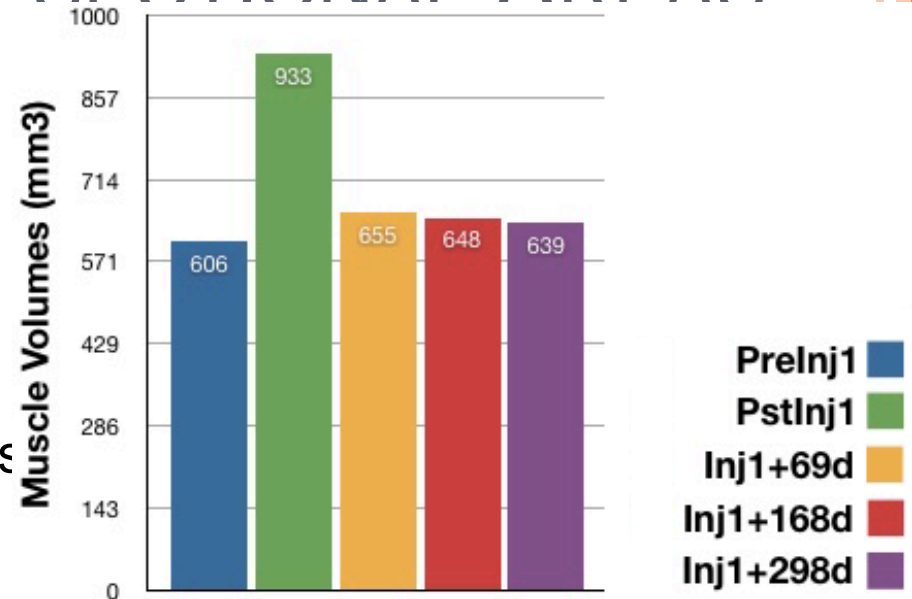
Rosenblatt & Woods, 1992. Rat, ext. digit. long.



VOLUMES & CROSS-SECTIONAL AREAS

○ Pre-Injection, post-Injection, and follow-up scans track changes in muscle volume

○ Cross-section analysis shows location of injection bolus (■), and pattern of regrowth (■, ■, ■)



BP TREATMENT OF STRABISMUS:

- Probably useful for 10-12Δ horizontal strabismus
- ?place in ptosis treatment



2ND EYE CATARACT SURGERY 1W LATER

- Diplopia same...2nd image now clearer.
- Symptoms dismissed [again] – it'll get better
- 2nd ophthalmologist: ..you're 6/6 OU...looks great ... I'm a cataract surgeon....

If you ignore a pt's symptoms, they don't go away.



DIPLOPIA FOLLOWING "ROUTINE" CATARACT SURGERY : MOTOR AND SENSORY CAUSES

- Motor cause – in days of blocks, were common in a strabismus practice; now very rare
- All types / variations of motor causes usually easily recognised EXCEPT torsional diplopia : you have to **ask the pt: is the 2nd image tilted?**
- If pt doesn't behave like the typical IR palsy- then- fibrosis : Image
- Occult Graves' an irregular surprise





ANISEIKONIA AND OTHER 'NEW' CAUSES OF DIPLOPIA

**DEVICE TECHNOLOGIES ORTHOPTIC CONTINUING
EDUCATION SERIES” 2012**

Lionel Kowal RVEEH & Private Eye Clinic

**Assisted by past / present PEC orthoptists & RVEEH
Fellows**

ANISEIKONIA AND OTHER 'NEW' CAUSES OF DIPLOPIA : SUMMARY

- Pre-existing small asymptomatic horizontal \pm vertical phoria becomes symptomatic tropia with diplopia if fusion is subtly disrupted
- Need to identify the factor[s] that disrupt fusion
- Need to compensate for the factor[s] that disrupt fusion



OLD DIPLOPIA QS

- Does the 2nd image go away when you close either eye?
- Is it to the L / R / above / below?
- Does the L / R / higher / lower one go away when you close the L / R eye?
- Is one tilted? Which one? Tilted in / out?
- Is there a position where the doubling is gone? ..is worst?



'NEW' DIPLOPIA QS –

UNDER-RECOGNISED **SENSORY** & **MOTOR** BARRIERS TO FUSION

Is the image seen by the R:

- **Larger / smaller than image seen by L**
- **Same shape as L**

Are the horizontal and vertical lines on the E as they should be

- **Paler / darker than L**
- **Tilted** [torsion]
- [if vertical] **Does it go away when the head is flat e.g. lying down on your back?** [Skew]
- **Does it wobble?** Heimann Bielschowsky, Sup Obl Myokymia, Ocular myoclonus,...



CASE 1: REDUCING ANISOMETROPIA - “SENSIBLE” CATARACT SURGERY

- 56 yo Dr for R phaco/IOL
- Pre-op refractions (SE)
- **R -8 D L -2.5 D**
- Post-op refractions (SE)
- **R +0.25 D (6/8) L -2.5 D (6/6)**
- & CONSTANT DIPLOPIA**
- PCT = XT 8 Δ, LHT 8 Δ

Presumably this was all asymptomatic phoria before cataract surgery



DIPLOPIA AFTER CATARACT SURGERY

'Old' reasons	'New' reasons : Normal or near-normal muscle function: usually ≥ 1 'minor' stresses on sensory & motor fusion
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	Minor acquired motility changes of the elderly: Sagging eye muscles



KNAPP'S RULE

- **Axial anisometropia corrected in the spectacle plane doesn't usually cause aniseikonia**



56 YO DR

CAUGHT “KNAPPING”? *

- If ***Axial*** anisometropia is converted to ***Lenticular*** anisometropia, then **aniseikonia is to be expected**
- Aniseikonia impairs motor & sensory fusion and will predispose to diplopia [esp if there is also a (hitherto) trivial motor phoria]
- Axial lengths : R 29.48 mm L 26.75 mm
- Now has **13% R macropsia**

Likely to have been anticipated by pre-op CL testing

- Galilean system has resolved diplopia by minimising RE image : + CL [start +1.50, with equivalent - to spectacle lens]
- Opposite optical arrangement to LE
- Trial / error, or use **Aniseikonia Inspector** ©

**Thank you Logan Mitchell*



MEASURING ANISEIKONIA

- Free Space Estimation

LK: experience ++, preference +

- Space Eikonometer (Stereoscopic method)

LK: no experience

- Awaya Test (Direct Comparison Method)

LK: experience ++, preference ±

- Size [Thick] lenses

LK: experience +, preference ++

MEASUREMENT ARTEFACT –
each technique can give a different answer



DIFFERENCES IN TESTS OF ANISEIKONIA

GLEN MCCORMACK,* ELI PELI,T AND PATRICK STONE*

IOVS, VOL. 33, NO. 6, MAY 1992

- We compared validity of NAT to the Space Eikonometer in 3 experiments: (1) aniseikonia was induced by calibrated size lenses in a double-blind study of 15 normals; (2) habitual aniseikonia was measured with both instruments in 4 pts; and (3) 8 normals retested with a computer-video simulation of NAT.
- **The NAT underestimated induced aniseikonia by a factor of 3 in normals and underestimated habitual aniseikonia in 4 pts.**
- The Space Eikonometer correctly measured the magnitude of induced aniseikonia in normals. The simulation test did not show underestimation in the 8 normals.
- We could not attribute NAT's underestimation of aniseikonia to the red/green anaglyph method, printing error, psychophysical method, or the direct-comparison test format.
- **We speculate that NAT induces a different sensory fusion response to aniseikonia than do the other tests, and that this altered sensory fusion response diminishes measured aniseikonia.... NAT is not a valid measure of aniseikonia.**
- *LK: does not exclude it's continuing use in the one patient: measures 'NAT aniseikonia' not 'True aniseikonia'*



56 YO DR

2 VERY IMPORTANT QS

1. How much anisometropia is it safe to surgically **reduce** to try produce glasses independence?

○ No data

2. How much anisometropia is it safe to surgically **introduce** in order to give monovision MV?

○ Some data



Patient satisfaction and visual function after pseudophakic monovision

Yaron M. Finkelman, MD, Jonathon Q. Ng, MBBS, PhD, Graham D. Barrett, FRACS, FRACO

J Cataract Refract Surg 2009; 35:998-1002 © 2009 ASCRS and ESCRS

27 pts

Target refraction for 2nd eye -1 to -1.5

Mean introduced anisometropia 1.16 DS

Ignored all the usual 'Dominant' wisdoms

STEREO:

Mean 176", median 70", range 40-800. Authors considered this normal.

GLASSES INDEPENDENCE:

Scale 0 -10.

0: independent [27%]. 10: totally dependent [4%]

60% 0-2. Mean score 2.7 for near, 1.6 for distance

No objective orthoptic measurements

No unhappy pts

....another bad study



Visual Outcomes of LASIK-Induced Monovision in Myopic Patients With Presbyopia

MONTSERRAT GARCIA-GONZALEZ, MIGUEL A. TEUS, AND JOSÉ L. HERNANDEZ-VERDEJO

Amer J Ophthalmol Sept 2010

- ...success rate for CL-induced MV varies from 50 – 76%
- ...refractive surgery MV.... patient satisfaction rate ranging from 72-96%
- ...a significant rate of non- success



SURGICAL / PERMANENT MV ≠ INTERMITTENT / TEMPORARY MV 1

- 3 month MV [early PRK days] :
1/50 pts asymptomatic
reduction in fusional reserve

White J. Excimer laser photorefractive keratectomy: the effect on binocular function. In Spiritus M (Ed): Transactions, 24th Meeting, European Strabismological Association. Buren: Acolus Press, 1997; 252 – 56



SURGICAL / PERMANENT MV

≠ INTERMITTENT / TEMPORARY MV 2

118 RS patients. 48 planned MV.

'Abnormal binocular vision' (ABV) in 11/48 (22%), ≥ 1 of

- *Intermittent / persistent diplopia*
- *Visual confusion*
- *'Binocular blur requiring occlusion to focus comfortably'.*
- 70 pts did not have MV, 2 had ABV (3%).

Average anisometropia in

- 13 pts with ABV: 1.90 DS
- 105 pts with normal BV: 0.50 DS ($p < 0.001$).

Kowal L, De Faber J, Calcutt C, Fawcett S. 'Refractive surgery and strabismus' (Workshop in 'Progress in Strabismology').

In: de Faber JT, ed. Proceedings of the 9th Meeting of the International Strabismological Association, Sydney, Australia.



SURGICAL / PERMANENT MV

≠ INTERMITTENT / TEMPORARY MV 3

- 3 pts with MV IOLs who developed ET with diplopia ≥ 2 y after IOLs
- **Rx:** Reverse the MV

Pollard et al Am J Ophthal 2011

This paper also contained examples of CL MV causing delayed diplopia



HOW MUCH ANISOMETROPIA IS IT SAFE TO:

1. REDUCE?

2. INTRODUCE ?

- 1. Evidence based:

Reduce: no evidence

Introduce:

RS cohort: 1.9DS too much; ~20% have ABV

In RS MV cohort, commonest cause for re-Rx is usually DISTANCE correction, not MV-associated issues

BraunEH... Monovision in LASIK. Ophthalmology 2008; 115:1196–1202.

Small IOL cohort: 1.16DS probably acceptable



HOW MUCH ANISOMETROPIA IS IT SAFE TO:

1. REDUCE?

2. INTRODUCE ?

- 2. Eminence based: ..introduce / reduce as little as possible.
- Anisometropia in RS: 'mini- MV' 0.5 to 1.5 DS... others up to 2.75DS
- No universally accepted criteria for IOL-MV.

Common: Full distance Rx to dominant eye.

Ocular Dominance: hole- in- card to VEP. Some 'cross MV'.

? ignore dominance '....in most patients, ocular dominance is not fixed but is rather a fluid phenomenon with significant higher cortical adaptation'

EvansBJ. Monovision:areview. OphthalmicPhysiolOpt2007;27:417-439.

- **Every time you reduce or introduce anisometropiathere is an unknown [?] low % of problem patients, and the % probably increases with time after surgery.**



"UNPUBLISHED INTERNAL AUDIT DATA FROM AN AUSTRALIAN MULTI CENTER REFRACTIVE SURGERY PRACTICE"

- Need for repeat refractive surgery after planned monovision surgery:
- 15% after CL trial, 50% without.



DIPLOPIA AFTER CATARACT SURGERY

'Old' reasons	'New' reasons : Normal or near-normal muscle function: usually ≥ 1 'minor' stresses on sensory & motor fusion
Inf Rectus contracture after Marcaine damage	Anisometropia: Monovision & Aniseikonia
Other muscles damaged by Marcaine	Metamorphopsia 2ary to macular disease
Incidental 4ths and occult Graves' Ophthalmopathy uncovered by cataract surgery	Other sensory issues: Big contrast differences, large field defects.
	Minor acquired motility changes of the elderly: Sagging eye muscles



SCIENTIFIC REPORT

Aniseikonia associated with epiretinal membranes

M Ugarte, T H Williamson

Br J Ophthalmol 2005;89:1576–1580. doi: 10.1136/bjo.2005.077164

Aims: To determine whether the computerised version of the new aniseikonia test (NAT) is a valid, reliable method to measure aniseikonia and establish whether aniseikonia occurs in patients with epiretinal membranes (ERM) with preserved good visual acuity.

Methods: With a computerised version of the NAT, horizontal and vertical aniseikonia was measured in 16 individuals (mean 47 (SD 16.46) years) with no ocular history and 14 patients (mean 67.7 (14.36) years) with ERM. Test validity was evaluated by inducing aniseikonia with size lenses. Test reliability was assessed by the test-retest method.

Results: In normal individuals, the mean percentage (SD) aniseikonia was -0.24% (0.71) horizontal and 0% (0.59) vertical. Validity studies revealed mean (SD) 0.990 (0.005) horizontal and 0.991 (0.004) vertical correlation coefficients, 0.985 (0.111) horizontal and 0.989 (0.102) vertical slope. Repeatability coefficients were 1.04 horizontal and 0.88 vertical. Aniseikonia in patients with ERM ranged from 4% to 14%. Eight patients showed 2% or more size difference between horizontal and vertical meridians.

Conclusions: The aniseikonia test used in this study can be considered a simple, fast, valid and reliable method to measure the difference in image size perceived by each eye. Aniseikonia does occur in symptomatic patients with ERM. The effect of ERM on image size is heterogeneous across the retinal area affected.

consisting of graded stereoscopic cards reproducing the space eikonometer target was developed later on.⁷ The performance of this test requires good stereopsis. This is known to be reduced in patients with aniseikonia, making its results unreliable. The NAT measures aniseikonia directly, by presenting a red and a green semicircle to each eye by means of dissociation with red/green goggles. It is easy and rapid to perform^{2,8} and we consider it ideal for clinical use. We used a computerised version of the NAT after confirming its validity and reliability to measure aniseikonia in symptomatic patients with unilateral macular ERM.

MATERIALS AND METHODS

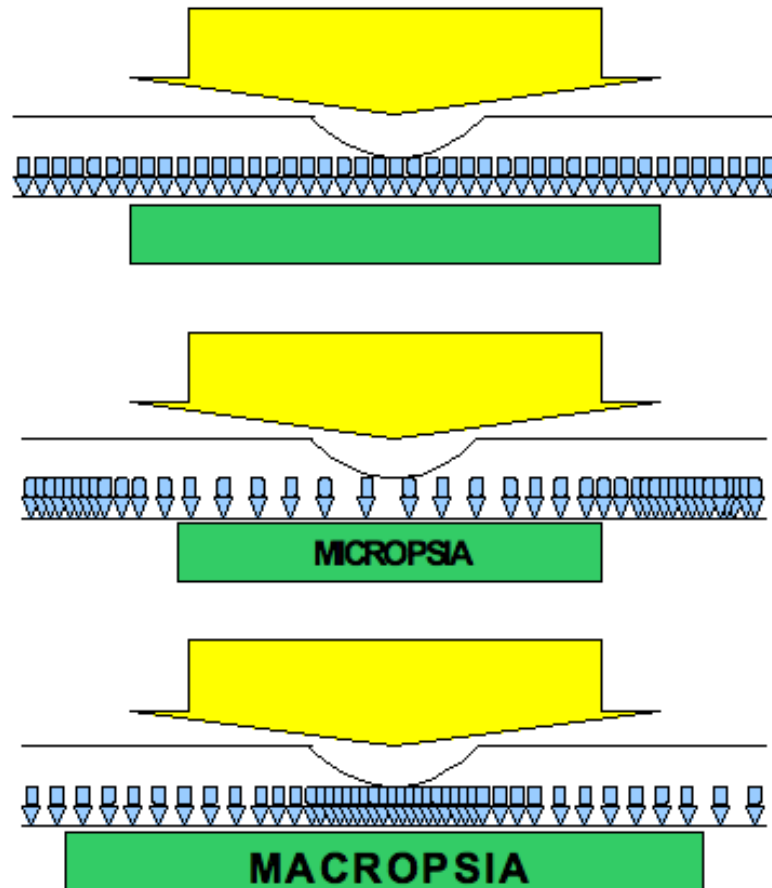
Sixteen volunteers, mean age 47 (SD 16.46), 10 women and six men, without ocular history and less than 1 dioptre (D) anisometropia were included in the control group. Fourteen patients, mean age 67.7 (SD 14.36), five women and nine men, with ERM were recruited between October 2003 and December 2004. Inclusion criteria were visual complaints, less than 1 D anisometropia, logarithmic minimum angle of resolution (logMAR) visual acuity (VA) 0.5 or better in each eye, and unilateral macular ERM. The research carried out followed the tenets of the World Medical Association Declaration of Helsinki. Subjects underwent ocular examination, refraction, best corrected VA, orthoptic assessment, metamorphopsia analysis with Amsler chart, threshold horizontal and vertical aniseikonia measurement, slit lamp examination, and funduscopy.



MODERN MACULAR TREATMENTS PRESERVE ACUITY BUT DO NOT PREVENT METAMORPHOPSIA & ANISEIKONIA

Retinal Causes

- Distortion of foveal photoreceptor distribution
 - ERM
 - Retinal detachment
 - Macular hole
 - Macular surgery



Can be occult until vision improving surgery



FIELD-DEPENDENT ANISEIKONIA ASSOCIATED WITH AN EPIRETINAL MEMBRANE

DE WIT & MURAKI

OPHTHALMOLOGY 2006;113:58 – 62

- ***Aniseikonia may vary with Visual Field Angle due to a retinal cause such as an epiretinal membrane.***
- ***...field-dependent aniseikonia ... cannot be corrected fully with conventional optics, which exhibit an approximately constant magnification as a function of VFA. Nevertheless, by correcting 5% to 10% aniseikonia, which showed up in the VFA measurement range at 2° to 3°, our patient had improved visual comfort, especially for reading.***



DIPLOPIA SECONDARY TO ANISEIKONIA ASSOCIATED WITH MACULAR DISEASE

ARCH OPHTHALMOL. 1999;117:896-899

NANCY M. BENEGAS, MD; JAMES EGBERT, MD; W. KEITH ENGEL, MD; BURTON J. KUSHNER, MD

- 7 patients : diplopia & epiretinal membranes (6/7) or vitreomacular traction (1/7).
- **All had aniseikonia, 5% - 18% [Awaya].**
- 5 : the image in involved eye was larger, 2 smaller.
- All had concomitant small-angle strabismus and at least initially did not fuse when the deviation was offset with a prism.
- Variable response to optical management & retinal surgery.
- **Concomitant small angle strabismus and the inability to fuse with prisms may lead the clinician to the incorrect diagnosis of central disruption of fusion. Surgical intervention does not necessarily improve the aniseikonia.**



A PROSPECTIVE STUDY OF BINOCULAR VISUAL FUNCTION BEFORE AND AFTER SUCCESSFUL SURGERY TO REMOVE A UNILATERAL EPIRETINAL MEMBRANE

- 2/27: diplopia
- Measured stereo, motor fusion & VA.
- Stereo & total motor fusion ranges reduced
- After successful surgery, stereo function, VA & motor fusion improved mainly in those with shorter duration of symptoms [esp < 18mo]
- Stereo function improved mainly in those with better preoperative stereo



MANAGEMENT OF RETINALLY INDUCED ANISEIKONIA A CASE STUDY

George Sahely

Optometrist, Mornington

...with interest in Aniseikonia

PATIENT HISTORY

- Marlene, 66 year old female
- Longstanding horizontal prism to control esotropia
- Bilateral cataract surgery 2 years earlier
- Recent R: Macular membrane
- **Macropsia**
- **Secondary breakdown in fusion**
- Main complaint tired eyes and diplopia
- Wearing Rx: R: plano/ -0.50 x 169
L: plano/ -0.50 x 28 Add + 2.50 DS

INITIAL FINDINGS- 27/10/09

- Unaided vision R: 6/12-- L: 6/7.5
- Rx: R: pl/-0.50 x 165 (6/7.5) L: pl/-1.00 x 13 (6/6-)
- Demonstrable sensory fusion and motor fusion range
- Distance phoria R: 13 eso, 1.5 BUR (variable)
- Near phoria (Howell card) 13 eso
- Fusional reserves 6m PRC: -/25/10 NRC: Diplopia
- Vertical reserves BUR: -/4/3 BUL: -/1.5/-
BDR: -/2/1 BDL: -/5/3.5

At near breaking into strab, though through 10 base out prism PRC -/25/10 NRC -/10/8



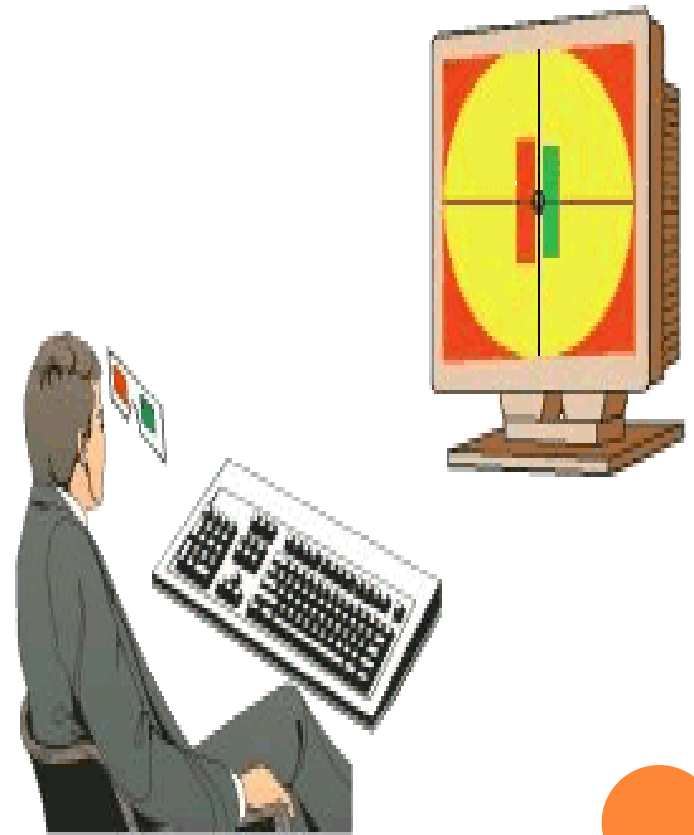
INITIAL FINDINGS CON'T

- Internal: R: Moderate epiretinal membrane /traction
L: mild macular atrophic changes
- Patient was capable of fusion, though fragile with query on the effect of aniseikonia
- Determined BASE Rx: of
R: plano/-0.50 x 165 L: plano/-1.00 x 13 Add +2.75
Total 9 BO and 1.5 BU R prism

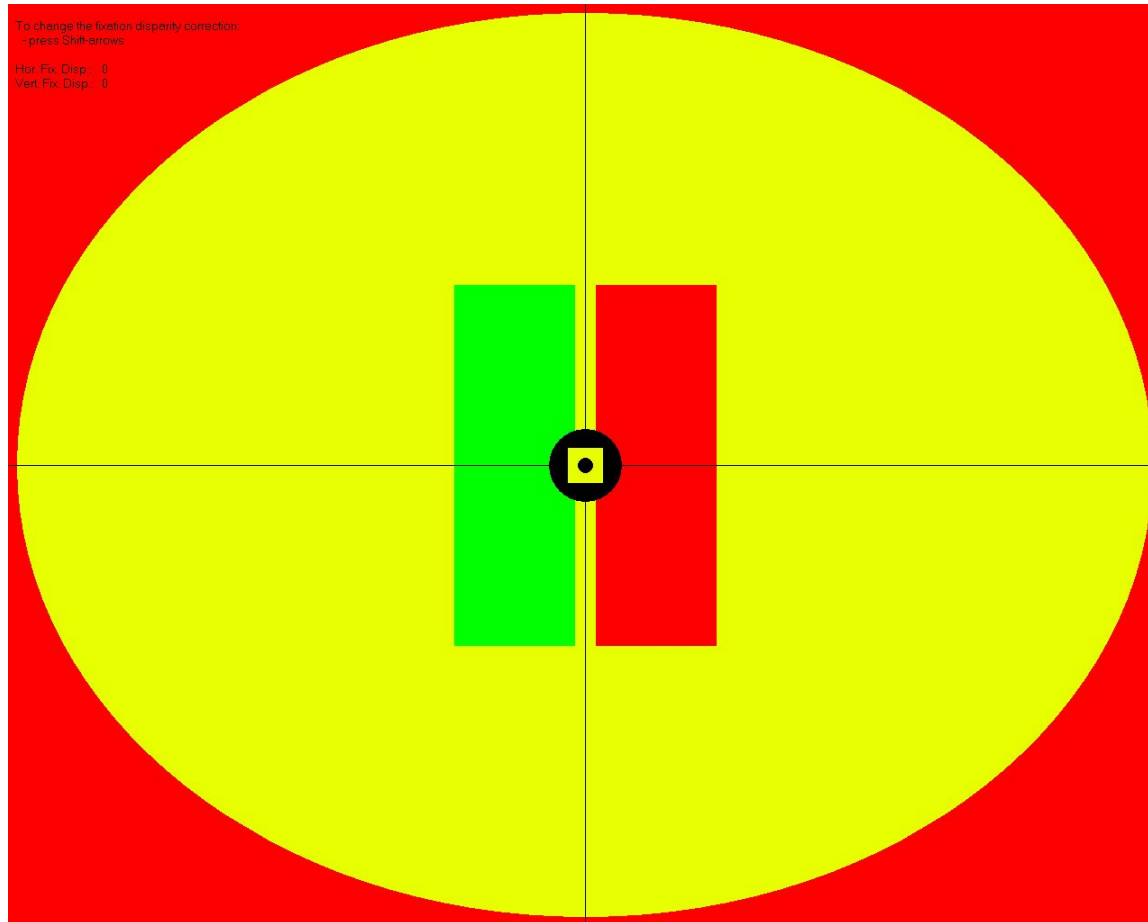


ANISEIKONIA INSPECTOR

- Designed by Gerard De Wit
- Direct comparison method of the perceived images
- Patient fixates centrally whilst the images flash for 0.5 sec (static aniseikonia)
- Field angle is set by the size of the rectangles



ANISEIKONIA INSPECTOR TESTING

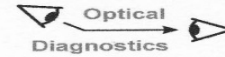


ANISEIKONIA CALCULATIONS

- With habitual glasses we need their Rx, RI, Base curve, centre thickness and vertex distance
- With trial lenses this is factored into the software program
- For Marlene subjective results were too variable with the field dependency test (smaller field angles are less accurate)
- Reverted to a custom 8 degree field test in 4 meridians.



Aniseikonia Test Result



Last name: ██████████
 First name: Marlene

ID: 251109
 Date of birth: Jan 19, 1943 (66 years)

Preset aniseikonia

Date/time: Nov 25, 2009 (11:06 PM)
 Test duration: NA
 Software version nr: 3.3b
 OD Filter: NA
 Fix. Disp. correction: NA
 Test strategy: NA
 Stim. viewing time: NA
 Prescription type: Glasses (OD/OS)
 Sphere: 2.25 / 2.25 D
 Cylinder: -0.50 / -1.00 D
 Axis: 165 / 13 deg
 Front curve (1.53): 6.80 / 6.80 D
 Center thickness: 2.2 / 2.2 mm
 Refractive index: 1.498 / 1.498
 Vertex distance: 12.0 / 12.0 mm

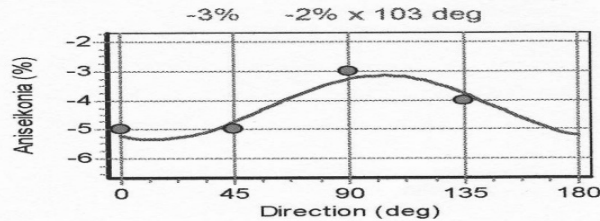
Comments
 Rx: set for ~ 40 cm computer distance, using trial lenses with 10 base out prism and 1.5 base up right, split ~ equally

Results summary

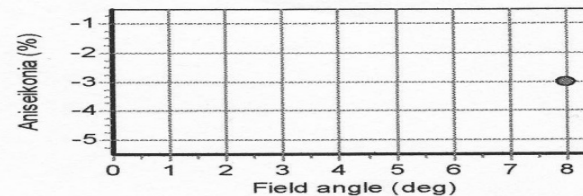
Field angle (deg)	Vertical (%)	Horizontal (%)	Diagonal 1 (%)	Diagonal 2 (%)
8.0	-3	-5	-5	-4
4.0	NA	NA	NA	NA
2.0	NA	NA	NA	NA
1.0	NA	NA	NA	NA
0.5	NA	NA	NA	NA

* Inconsistencies

Aniseikonic ellipse (VHDD, 8.0 deg field angle)



Field dependency (vertical direction)



MINIMISING ANISEIKONIA

- Contact lenses
- Telescopic systems
- Lens centre thickness
- Lens base curve
- Refractive indices
- Bevel position /vertex distance
- Monocular blur / patching – central/sectoral /
Bangerter filters



LENS FACTORS INCREASING MAGNIFICATION



Front base curve



Refractive index



Central thickness



Vertex distance in + lens
(Opposite for minus lens)



New iseikonic Rx summary



Last name: ██████████

ID: 251109

First name: Marlene

Date of birth: Jan 19, 1943 (66 years)

New Rx

Contact lenses

	OD	OS	
Sphere	1.50	-1.50	D
Cylinder	0.00	0.00	D
Axis	90	180	deg
Center thickness	0.200	0.200	mm

Glasses

	OD	OS	
Sphere	-1.50	1.50	D
Cylinder	-0.50	-1.00	D
Axis	180	180	deg
Front curve (S)*	6.80	6.80	D
Front curve (C)*	NA	NA	D
Front curve axis	NA	NA	deg
Refractive index	1.498	1.498	
Center thickness	2.2	2.2	mm
Vertex distance	14.1	14.1	mm
Bevel	80	127	%
Lenticular diameter	NA	NA	mm
PD	28.0	28.0	mm
Vert. decentration	0.0	0.0	mm
Eyewire distance		12.0	mm
Eye size (A)		48.0	mm
Eye size (B)		35.0	35.0
Bridge size		20.0	mm

*Front curve based on n=1.53

Results

Field angle: 8.0 deg
 Based on examination: 002
 2009-11-25
 Both C+G
 VHDD

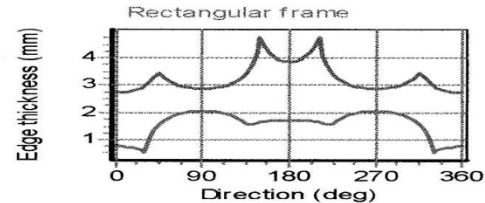
	Aniseikonia		
	'Old'	New	
Overall	-3.2	1.3	%
Meridional	-2.2	-2.7	%
Axis	103	115	%
V	-3.0	1.1	%
H	-5.0	-0.7	%
D1	-5.0	-1.3	%
D2	-4.0	0.8	%

Induced anisophoria (per 10 deg eye rotation)

V	0.2	-1.1	Δ
H	0.0	-1.4	Δ
D1	0.0	-1.2	Δ
D2	0.3	-1.2	Δ

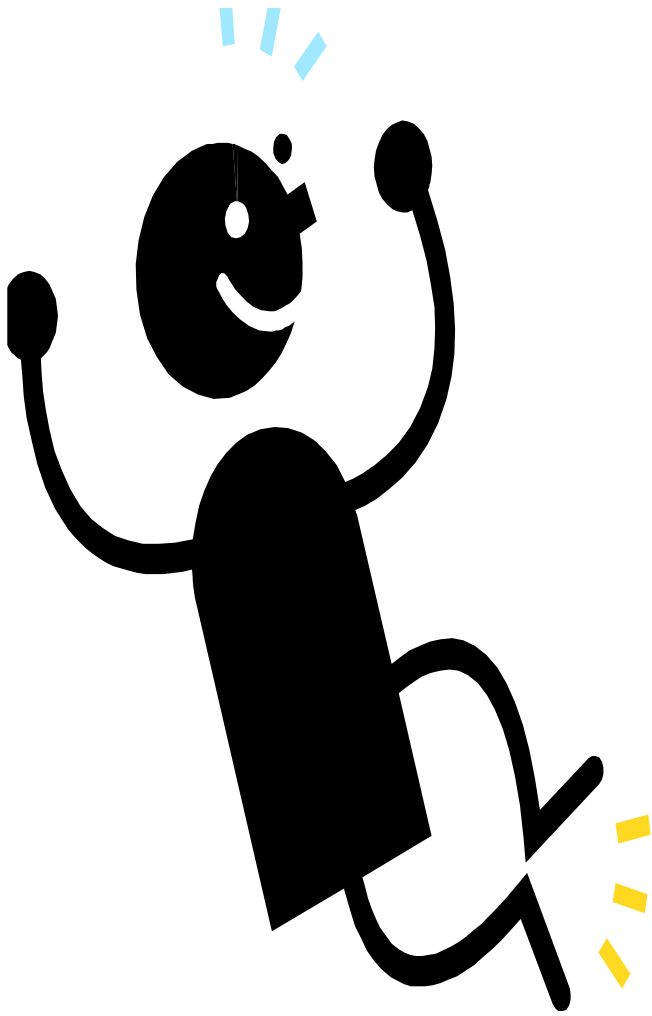
Comments

Best compromise on reducing anisok and anisophoria



- 10/12/09: Chose to try a telescopic system
- 1. Provision Premium 2w disposable CL
R: +1.50 L: -1.50
- 2. Over spectacles R: -1.50 / -0.50 x 165
L : +1.50 / -1.00 x 13 Add: +2.75
1.5 BUR 9 BO





- No diplopia
- No fatigue
- Rediscovered love of reading
- HAPPY (less irritable)



THE KOWAL EXPERIENCE 2009

- 12 patients
- Aged 29-86
- M:F 9:3



PRESENTING SYMPTOMS

- 11 Diplopia
- 1 Wobbling of words

- 9 Anisometropia
- 4 Macular causes
 - 3 ERM
 - 1 Macular hole



ANISEIKONIA

- 11/12 Reported aniseikonia
- The least amount of aniseikonia causing disruption of fusion was 2%
- Largest amount of aniseikonia was 20 %
- Average 6.4% (Mode 5%)



SENSORY FUSION

- 10/12 had measurable stereopsis
- Range - 'Fly' to 50"
- No relationship between stereopsis and degree of aniseikonia



MOTOR FUSION

- 8/12 - vertical deviation
 - ? vertical fusion is more fragile than horizontal ?
- 6/12 - horizontal deviations
- 2/12 - exophoria with poor fusion range

TREATMENT - OPTICAL

- 5 - modified spectacles + prisms
- 1 - contact lenses
- 1 - reduced prescription of near add on one lens
- 1 - telescopic lenses (+ve CL and –ve spectacle lens) 20% ANISEIKONIA



TREATMENT - OTHER

- 2 - surgery for exotropia
- 1 - declined treatment
- 1 - failed CL - referred for size lenses



ANISEIKONA AND MOTOR FUSION

- In most patients, aniseikonia precipitates small angle strabismus due to loss of sensory fusion which in turn impairs motor fusion
- Compensation for the strabismus with prisms along with lenses modified to compensate for the aniseikonia worked in 5/7 optically corrected patients



ANISEIKONIA AS A SUBSTANTIAL FACTOR IN CAUSING DIPLOPIA

- Probably rare
- ***Always unrecognised by referring practitioner***
- Need to ask about it - **pt always knows but needs to be asked the right question!**
- Often fixable with prisms and aniseikonic modifications



DIPLOPIA AFTER CATARACT SURGERY

'Old' reasons	'New' reasons : Normal or near-normal muscle function: usually ≥ 1 'minor' stresses on sensory & motor fusion
Inf Rectus contracture after Marcaine damage	Anisometropia: Monovision & Aniseikonia
Other muscles damaged by Marcaine	Metamorphopsia 2ary to macular disease
Incidental 4ths and occult Graves' Ophthalmopathy uncovered by cataract surgery	Other sensory issues: Big contrast differences, large field defects.
	Minor acquired motility changes of the elderly: Sagging eye muscles



CASE 2: SMALL VERTICALS: A NEWLY RECOGNISED MECHANISM FOR DIPLOPIA IN THE ELDERLY: **SAGGY EYE MUSCLES**

- 82 y o Intermittent Horizontal diplopia, mainly on left gaze, since cataract surgery 4y ago
- R 6/9, L 6/6

Horizontal Deviation:

0
0 ← 6ET → 12ET
6ET

Small L hypo in primary

- Prescribed glasses:
8Δ BO, 2Δ BU LE → single vision





**Restricted
depression
on L. aBduction**

Image size: 512 x 512
View size: 1141 x 635
WL: 355 WW: 710
X: 165 px Y: 368 px Value: 372.00
X: -44.11 mm Y: -69.73 mm Z: -65.18 mm

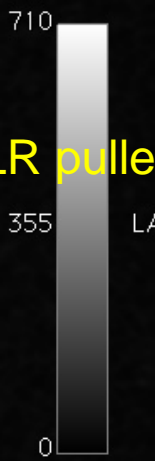
072571 (83 y , 83 y)
Orbits -Exclude Patholo - Cor T1 (Thin)
27408
8

'better' SR - LR
tissue sling

some atrophy of
LSR - LLR tissue sling

Sagging of LLR pulley

Not directly related to cataract surgery, but happens in same age group and will be attributed by patients to cataract surgery



Zoom: 270% Angle: 0
Im: 5/24 A (A -> P)
Uncompressed
Thickness: 3.00 mm Location: -57.83 mm

TE: 14.512 TR: 440
FS: 1.5
7/03/11 3:23:58 PM
Made In OsiriX

LR-SR INTER-MUSCULAR SLING

Degeneration of the LR-SR sling may occur in elderly

Inferior displacement of the LR Pulley.

LR is now a less capable abductor, & now has an infraduction vector as well

ET & Hypotropia

Demer JL et alii "Heavy Eye" Syndrome in the Absence of High Myopia: A Connective Tissue Degeneration in Elderly Strabismic Patients [J AAPOS. 2009 February; 13\(1\): 36-44.](#)

HIGH RISK #2: BEWARE OF MONOVISION

There are **insufficient prospective studies** that can tell us which pts are safe for IOL MV


You need to tell MV pts that there is a small risk [?%] of problems that seem to be fixable by reversing the MV.

Sometimes these problems can present 2-3 y after surgery.

CL testing probably <100% predictive



HIGH RISK #3 : BEWARE MACULAR MEMBRANES

- Metamorphopsia / aniseikonia can be beyond the ability of optical devices to resolve
 - Cataract surgery can cause permanent diplopia in these pts
- 

SIZE LENSES

- Ideally used to verify the software results and determine in practice the minimum degree of image size change needed to attain optimum visual comfort, particularly in retinal induced astigmatism
- 5% Size lens: Plano, Cr-39
Base curve 10D
CT 7.0 mm



INDUCED ANISOPHORIA (DYNAMIC ANISEIKONIA)

- **Optical aniseikonia:**

Correcting aniseikonia generally reduces the anisophoria

- **Retinal aniseikonia:**

Correcting aniseikonia often induces anisophoria



MANAGEMENT CONSIDERATIONS

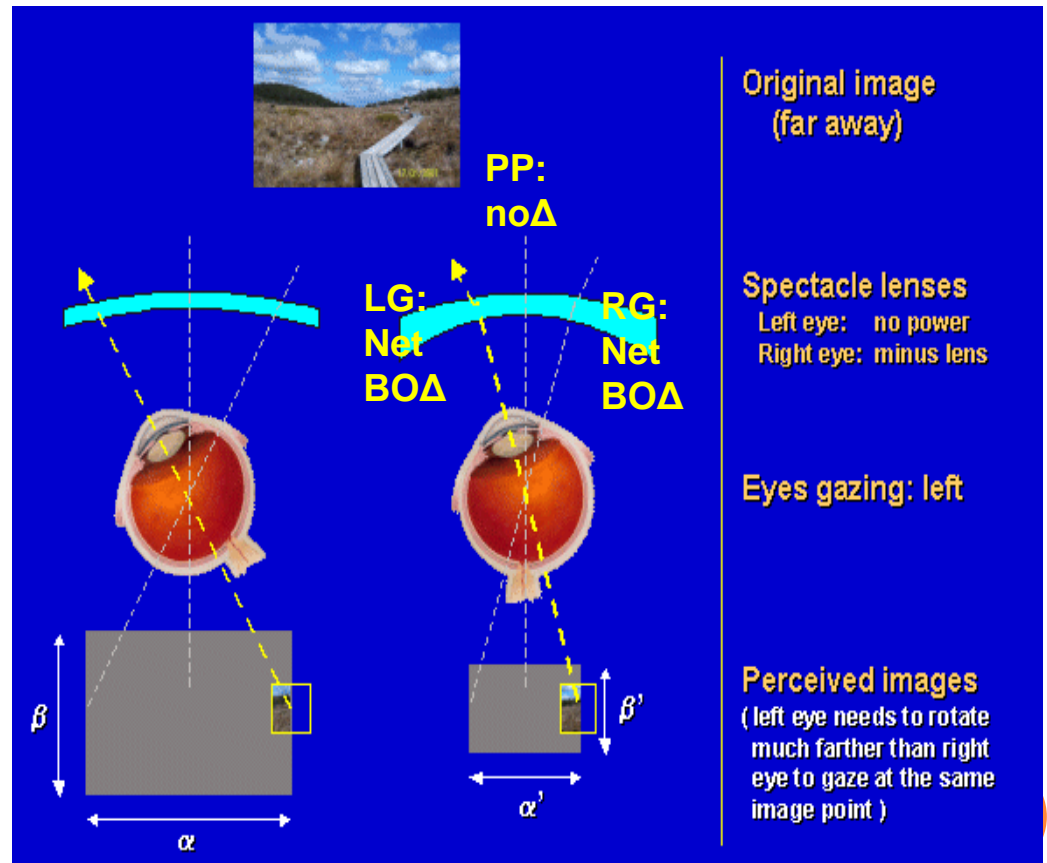
- Minimise aniseikonia

< 3%, < 1% ideal

- Minimise induced anisophoria - causes diplopia on lateral gaze

- Cosmetic factors

R & L spectacle base curves < 3D



LR-SR INTER-MUSCULAR SLING

Degeneration of the LR-SR sling may occur in elderly

Inferior displacement of the LR Pulley.

LR is now a less capable aBductor, & now has an infraduction vector as well

ET & Hypotropia

Demer JL et alii “Heavy Eye” Syndrome in the Absence of High Myopia: A Connective Tissue Degeneration in Elderly Strabismic Patients [J AAPOS. 2009 February; 13\(1\): 36–44.](#)

CASE 3: DIPLOPIA FOLLOWING "ROUTINE" CATARACT SURGERY

- 70 yo F
- High myope
- H diplopia after 1st cataract surgery
- 'It's because of the imbalance - will be better after 2nd eye is done'



2ND EYE CATARACT SURGERY 1W LATER

- Diplopia same...2nd image now clearer.
- Symptoms dismissed [again] – 'It'll get better'
- 2nd ophthalmologist: ..you're 6/6 OU...looks great ... I'm a cataract surgeon....

If you can't understand a pt's symptoms, it doesn't mean they are not there...or not important



CASE 3: HEMIANOPIA:

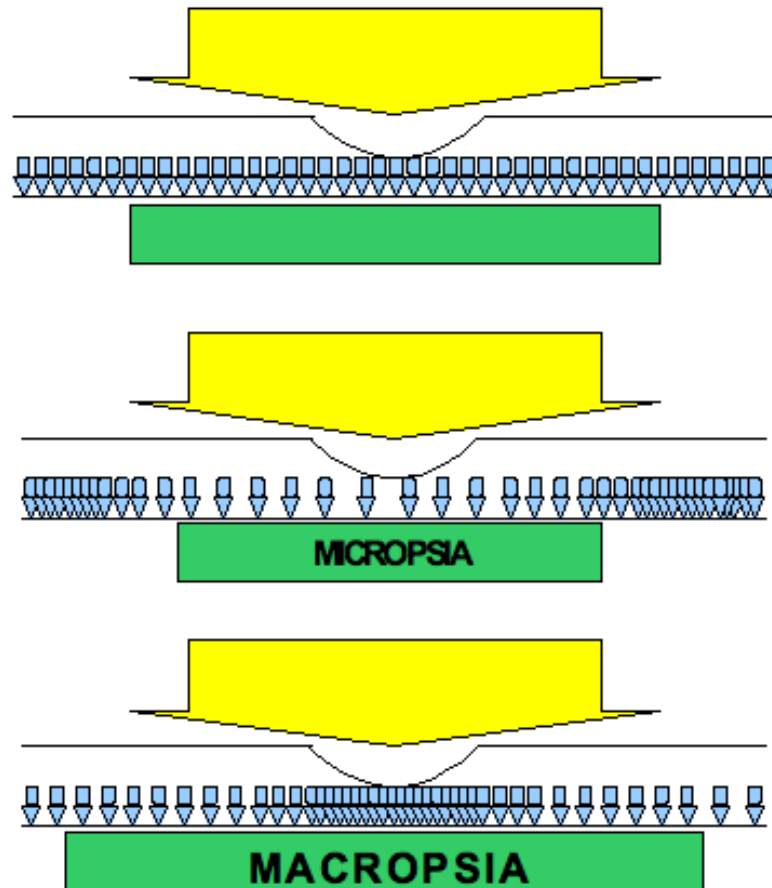
- If it's bad enough to cause loss of fusion = retinal slip, field loss won't be subtle and will be detectable on confrontation to movement of or counting fingers, losing $\frac{1}{2}$ a vision chart
- ...large pituitary tumour removed a few weeks later*



MODERN MACULAR TREATMENTS PRESERVE ACUITY BUT DO NOT PREVENT METAMORPHOPSIA & ANISEIKONIA

Retinal Causes

- Distortion of foveal photoreceptor distribution
 - ERM
 - Retinal detachment
 - Macular hole
 - Macular surgery



Can be occult until vision improving surgery



OPTICAL SOLUTIONS TO IN- /DE- CREASE IMAGE SIZE & RESOLVE DIPLOPIA

- Increase front base curve
- Increase central thickness
- Decrease BVD (- lens)
- Increase refractive index
- 'Thick' lenses
Special Order
Lenses we prescribe are always 'thin' lenses
- Prisms



....often successful!



HIGH RISK #1: BEWARE CORRECTING / 'IMPROVING' ANISOMETROPIA

- **Spectacles compensate for most cases of aniseikonia 2° to axial anisometropia BETTER than do IOLs or corneal refractive surgery**
- Converting R: -12, L: -4 to -2 DS OU runs a **real risk of PRODUCING aniseikonia**, abnormal binocular vision and permanent troublesome diplopia esp if there is a small hitherto asymptomatic & unrecognised phoria
- NO prospective studies to guide us how to handle anisometropic pts having IOLs



HIGH RISK #2: BEWARE OF MONOVISION

There are **no** prospective studies that can tell us which pts are safe for IOL Monovision

You need to tell MV pts that there is a small risk [?%] of problems that seem to be fixable by reversing the MV.

Sometimes these problems can present 2-3 y after surgery.

In one prospective refractive surgery planned MV study, pts with abnormal binocular vision had anisometropia av. 1.8DS, normal Binocular Vision 0.5DS [$p < 0.001$]



DIPLOPIA FOLLOWING "ROUTINE" CATARACT SURGERY : MOTOR AND SENSORY CAUSES

- Motor cause – in days of blocks, were common in a strabismus practice; now very rare
- All types / variations of motor causes usually easily recognised EXCEPT torsional diplopia : you have to **ask the pt: is the 2nd image tilted?**
- If pt doesn't behave like the typical IR palsy- then- fibrosis : Image
- Occult Graves' an irregular surprise



Visual Outcomes of LASIK-Induced Monovision in Myopic Patients With Presbyopia

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Amer J Ophthalmol
Sept 2010

- ...the success rate for CL-induced MV varies from 50 – 76%
- ...refractive surgery MV, patient satisfaction rate ranging from 72-96%
- ...a significant rate of non- success

