

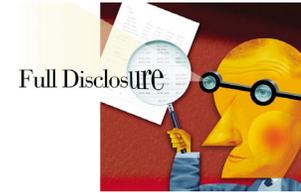
# Atropine Myopia Control

Jeffrey J. Walline, OD PhD



# Disclosures

- Bausch + Lomb: research materials



# Agenda

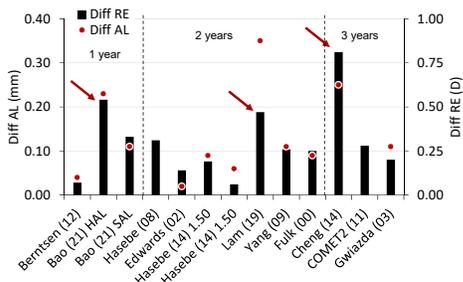
- Spectacle myopia control
- Atropine myopia control
- Combination therapies
- Atropine onset delay
- Outdoor time onset delay
- Effect of onset delay



# Spectacle Myopia Control



# Multifocal Spectacle Myopia Control



# Spectacle Myopia Control

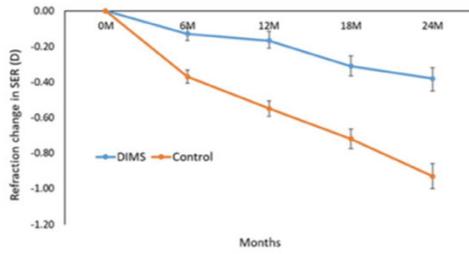


Lam CSY, et al. BJO 2019

Bao J, et al. BJO 2021

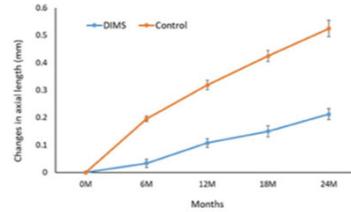


## Spectacle Myopia Control



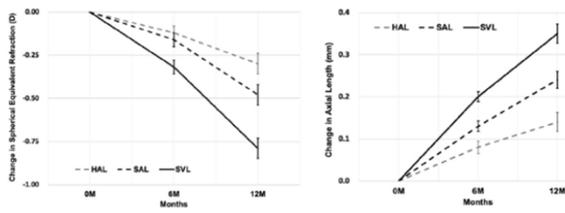
Lam CSY, et al. *Br J Ophthalmol.* 2019

## Spectacle Myopia Control



Lam CSY, et al. *Br J Ophthalmol.* 2019

## Spectacle Myopia Control



Bao J, et al. *BJO* 2021

## Spectacle Myopia Control

	DIMS	SV	p-value
Distance visual acuity (logMAR)	-0.02 ± 0.07	-0.01 ± 0.05	0.14
Near visual acuity (logMAR)	-0.02 ± 0.02	-0.02 ± 0.04	0.29
Near point of accommodation (D)	14.8 ± 2.1	15.3 ± 2.4	0.12
Accommodative lag (D)	1.10 ± 0.40	1.16 ± 0.55	0.43
Stereopsis (seconds of arc)	25.8 ± 4.2	29.0 ± 6.1	0.004



Lam CSY, et al. *Br J Ophthalmol.* 2019

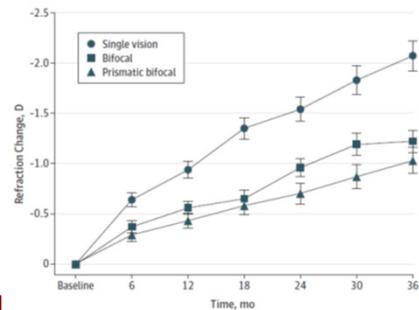
## Spectacle Myopia Control

**Not available in the United States**



Lam CSY, et al. *Br J Ophthalmol.* 2019

## Spectacle Myopia Control



Cheng D, et al. *JAMA Ophthalmol.* 2014;132:258-64

## Spectacle Myopia Control

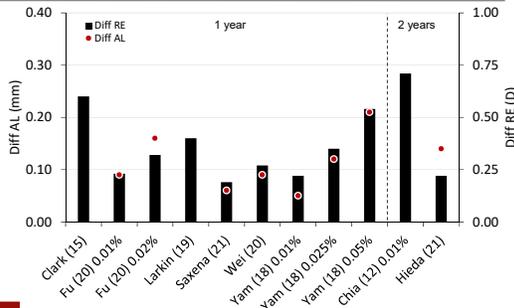
- Both studies deserve confirmation
- Executive BF enrolled only progressing myopes
  - -0.50 D or more in preceding year
- There is promise



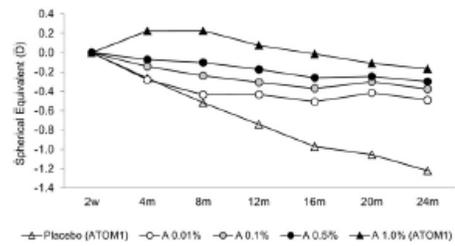
## Atropine Myopia Control



## Low Concentration Atropine



## Atropine Myopia Control



Chia A, et al. Ophthalmol 2012;119:347-54

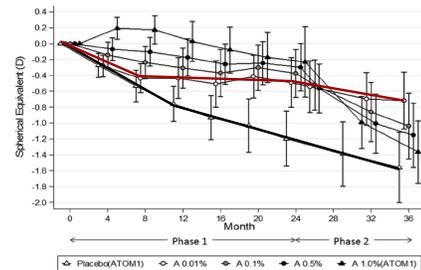
## Atropine Myopia Control

	0.01%	0.1%	0.5%
Accommo (D)	-4.6	-10.1	-11.8
Pupil (meso, mm)	1.15	2.71	3.56
Pupil (photo, mm)	0.75	2.24	3.11
Dist VA (logMAR)	-0.02	+0.01	-0.01
Near VA (logMAR)	-0.02	+0.06	+0.25
Reading specs (% yes)	6	61	70



Chia A, et al. Ophthalmol 2012;119:347-54

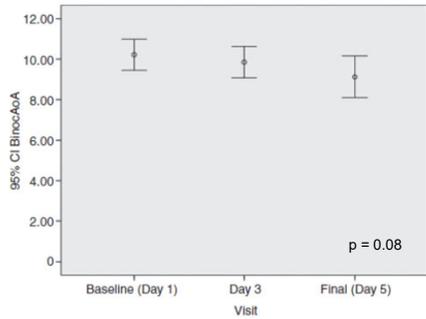
## Atropine Myopia Control



Chia A, et al. AJO 2014;157:451-7

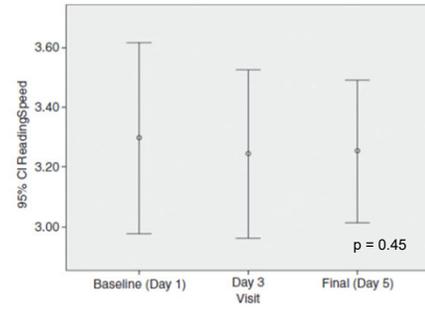


## Atropine Myopia Control



Loughman J, Flitcroft DI. Br J Ophthalmol 2016;100:1525-9

## Atropine Myopia Control



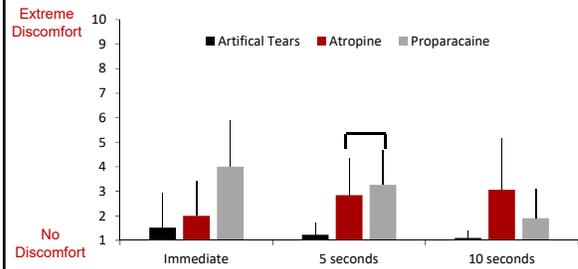
Loughman J, Flitcroft DI. Br J Ophthalmol 2016;100:1525-9

## Atropine Myopia Control

	Day 1	Day 3	Day 5	p-value
Distance VA (logMAR, OD)	-0.10 ± 0.10	-0.08 ± 0.07	-0.08 ± 0.05	0.55
Pupil size (mm, OD)	5.51 ± 1.74	6.55 ± 1.12	6.82 ± 0.61	0.04
Pupil Response	3.0 ± 0.0	2.8 ± 0.5	1.1 ± 0.9	<0.01
NPC (cm)	6.8 ± 2.4	7.0 ± 2.2	8.0 ± 3.2	0.25

Loughman J, Flitcroft DI. Br J Ophthalmol 2016;100:1525-9

## Atropine Myopia Control



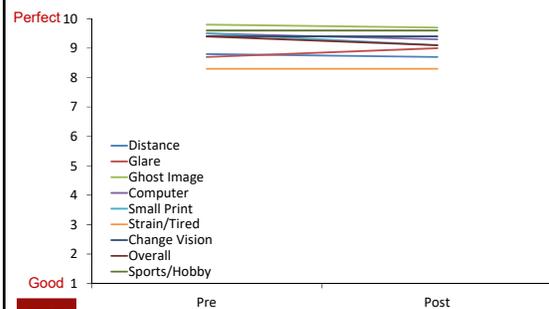
Ben Cyphers OD/MS Project

## Atropine Myopia Control

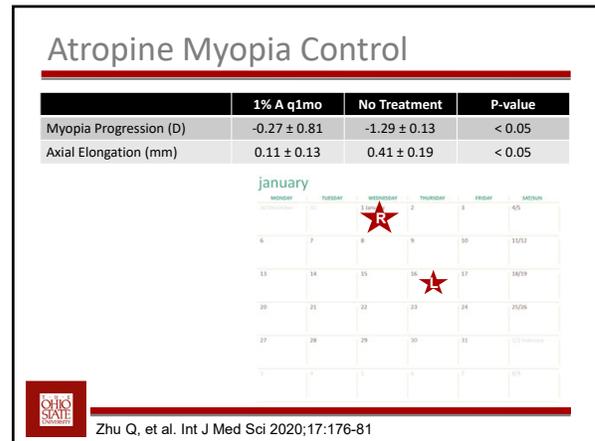
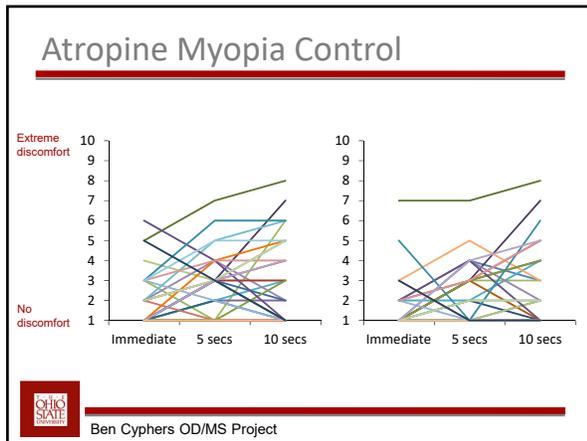
	Pre	Post	P-value
Reading speed (words/min)	173.4 ± 31.5	179.3 ± 30.9	0.01
Accommodative Amplitude (D)	8.1 ± 1.2	8.5 ± 1.3	0.10
Accommodative Facility (cyc/min)	13.6 ± 4.0	14.0 ± 3.8	0.24
Phoria (°)	-1 ± 6	-1 ± 6	0.74
IOP (mmHg)	15.6 ± 2.9	17.0 ± 3.2	0.001
Pupil (photopic, mm)	4.9 ± 0.8	5.1 ± 0.6	0.002
Pupil (mesopic, mm)	5.9 ± 0.7	5.9 ± 0.6	0.66
Likely to take drop (1=not; 10=yes)	8.2 ± 2.1	8.2 ± 2.0	0.08
Light Sensitivity (1=none; 10=very)	2.8 ± 2.5	3.1 ± 2.5	0.65
Light Discomfort (1=none; 10=extreme)	2.7 ± 1.9	2.0 ± 1.7	0.002

Ben Cyphers OD/MS Project

## Atropine Myopia Control



Ben Cyphers OD/MS Project



### Atropine Myopia Control

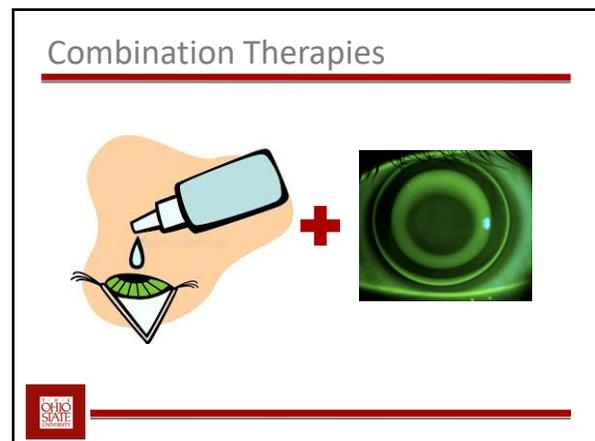
- 90/660 subjects withdrew
  - 22 control
  - 68 experimental
    - Photophobia and near vision complaints

	Maintained Therapy (n=262)	Ceased Therapy (n=68)	Total (n=330)
Photophobia	154/262 (58.78%)	51/68 (75.0%)	205 (62.12%)
Blurred Near Vision	56/262 (21.37%)	9/68 (13.24%)	65 (19.70%)
Headache	36/262 (12.8%)	3/68 (4.41%)	39 (11.82%)
Allergic Reaction	3/262 (1.1%)	0/68 (0%)	3 (0.9%)
Eye Irritation	59/262 (22.52%)	2/68 (2.94%)	61 (18.5%)
Infections (Conjunctivitis, Blepharitis)	18/262 (6.87%)	0/68 (0%)	18 (5.45%)

Zhu Q, et al. Int J Med Sci 2020;17:176-81

- ### 0.01% Atropine Myopia Control
- Follow-up
    - Accommodation
    - Pupil size
      - Same conditions every time
    - IOP
    - Near blur?
      - PAL
    - Photophobia
      - Transitions

- ### Atropine Myopia Control
- Low concentration atropine provides effective myopia control
    - Doesn't slow eye growth as much
  - No significant side effects
  - Recommend 1 gtt 0.05% atropine OU qhs
  - Perhaps 1% Atropine q1mo?
- 



## [Low] Atropine + OK

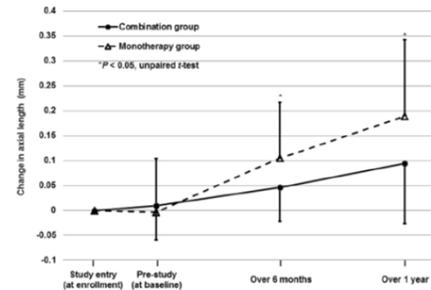
Myopia	[Atropine]	Combination	Orthokeratology	p-value
<6.00 D	0.125%	0.55 ± 0.12	0.58 ± 0.09	0.022
< 6.00 D	0.025%	0.65 ± 0.18	0.83 ± 0.16	0.029
≥ 6.00 D	0.125%	0.57 ± 0.17	0.64 ± 0.14	0.015
≥ 6.00 D	0.025%	0.58 ± 0.08	0.4 ± 0.15	0.023
All subjects	Both	0.59	0.61	N/A

"Combined treatment with atropine and OK lenses would be a choice of treatment to control the development of myopia."



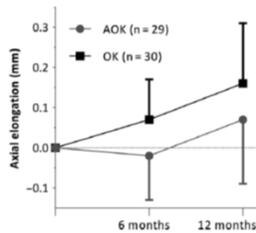
Wan L, et al. J Clin Med 2018;7:259

## 0.01% Atropine + OK



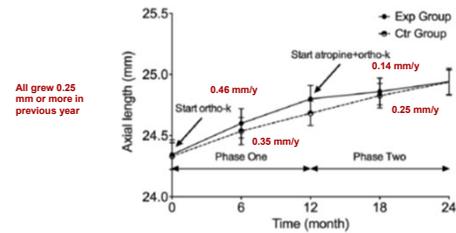
Kinoshita N, et al. Japan J Ophthalmol 2018;62:544-53

## 0.01% Atropine + OK



Tan Q, et al. Ophthalmic Physiol Opt. 2020;40:557-66

## OK Then OK Plus 0.01% Atropine



Chen Z, et al. Cont Lens Anterior Eye 2019;42:439-42.

## Soft Multifocal CL + 0.01% Atropine

- Contact lens myopia control
  - Optical effect
- Atropine
  - Receptors at the retinal or scleral level

**Bifocal &  
Atropine in  
Myopia Study**

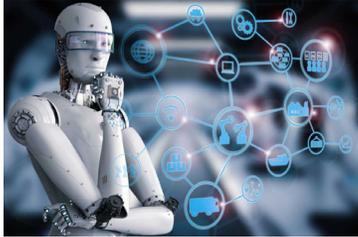


## Combination Therapies

- Orthokeratology + atropine provides stronger myopia control
  - May help as adjunctive therapy
- Soft Multifocal CL + atropine unknown



## Future of Myopia Control

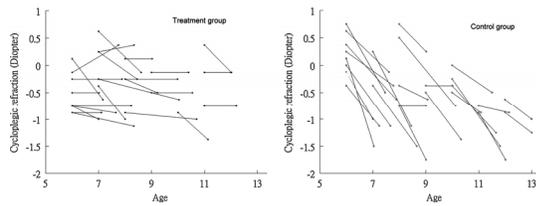


## Delay Onset

- 6-12 years
- SE +1.00 to -1.00
- F/u at least one year
- 0.025% atropine 1 gtt OU qhs



## Delay Onset



Fang PC, et al. J Ocul Pharmacol Ther 2010;26:341-5

## Delay Onset

	0.025% Atropine	Control	p-value
Myopia onset	21%	54%	0.016
More than -0.50 D/year	8%	58%	0.0002



## Outdoor Time Onset Delay

	Not Myopic		Myopic	
	Myopic Shift, Adjusted Estimate (n = 295; D/yr)	P Value	Myopic Shift, Adjusted Estimate (Diopters/Year)	P Value
School year (yrs)	0.07 (0.01-0.12)	0.017*	-0.10 (-0.17 to -0.03)	0.006*
Gender (boys vs. girls)	0.02 (-0.13 to 0.16)	0.794	0.07 (-0.11 to 0.26)	0.455
Baseline SER (D)	-0.12 (-0.34 to 0.02)	0.086	0.03 (-0.03 to 0.09)	0.320
Myopic parent (yes vs. no)	-0.01 (-0.15 to 0.14)	0.935	0.07 (-0.15 to 0.29)	0.515
Reading/writing (frequent vs. seldom or none)	-0.04 (-0.20 to 0.11)	0.547	0.16 (-0.05 to 0.37)	0.126
Computer (frequent vs. seldom or none)	0.10 (-0.08 to 0.27)	0.279	-0.08 (-0.27 to 0.12)	0.453
Other near work (frequent vs. seldom or none)	-0.03 (-0.21 to 0.15)	0.279	-0.01 (-0.25 to 0.22)	0.914
TV (frequent vs. seldom or none)	-0.03 (-0.32 to 0.24)	0.804	-0.19 (-0.53 to 0.15)	0.276
Outdoor activity after school (frequent vs. seldom or none)	0.07 (-0.07 to 0.22)	0.329	0.09 (-0.10 to 0.28)	0.340
Atropine treatment (yes vs. no)			0.02 (-0.20 to 0.23)	0.877
RCC program (yes vs. no)	0.18 (0.03-0.33)	0.020*	0.12 (-0.06 to 0.31)	0.183



Wu PC, et al. Ophthalmol 2013;120:1080-5

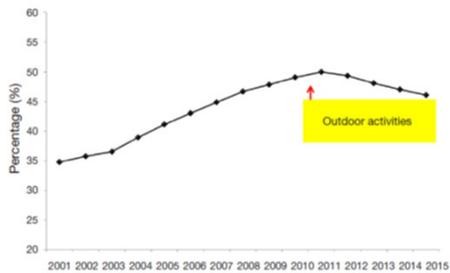
## Outdoor Time Onset Delay

	Intervention Group	Control Group	Difference (95% CI)	P Value
Cumulative incidence of myopia	259/853 (30.4)%	287/726 (39.5)%	-9.1 (-14.1 to -4.1)%	<.001
Cumulative change, mean (95% CI)%				
Spherical equivalent refraction, D	-1.42 (-1.58 to -1.27)	-1.59 (-1.76 to -1.43)	0.17 (0.01 to 0.33)	.04
Axial length, mm	0.95 (0.91 to 1.00)	0.98 (0.94 to 1.03)	-0.03 (-0.07 to 0.003)	.07



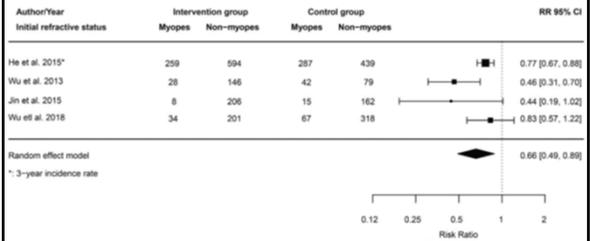
He M, et al. JAMA 2015;314:1142-8

## Outdoor Time Onset Delay



Wu P, et al. *Annals of Eye Science* 2018;3:1-4

## Outdoor Time Onset Delay



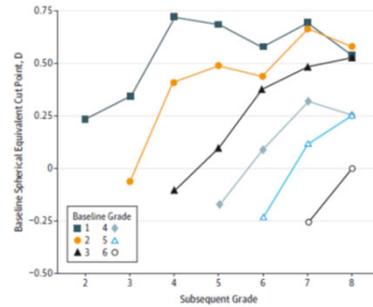
Deng L, Pang Y. *Optom Vis Sci* 2019;96:276-82

## Delay Onset

- Every year younger at onset
  - -0.86 D more myopic Chua 2016
  - 2.86 X more likely to be high myope Chua 2016
- If onset <10 years 26% high myopes, but onset >10 years only 1% Polling 2018



## Effect of Onset Delay



Zadnik K, et al. *JAMA Ophthalmol* 2015;133:683-9

## Effect of Onset Delay

	Myopia	Not Myopic
+0.75 to less myopic than -0.75	39	136
+0.75 or more hyperopic	6	373

Sensitivity = 86.7%  
Specificity = 73.3%

Adding corneal curvature, lens power, and axial length improves ROC from 0.880 to 0.893



Zadnik K, et al. *Invest Ophthalmol Vis Sci* 1999;40:1936-43

## Delay Onset

- Effective for delaying onset
  - Low concentration atropine
  - Outdoor time
- No direct proof this will ultimately lower myopia
  - May be more effective
- Education may not be enough
- Must seek pre-myopes
  - CL may not be best option



## Clinical Pearls

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- Offer options for myopia control
  - Spectacles, multifocal CL, orthokeratology, atropine
- Atropine doesn't slow eye growth much
- Combination treatment (OK + A) is effective
- Consider delaying onset of myopia
  - Low concentration atropine
  - Educate about outdoor time?

waline.1@osu.edu

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