

# Lowering of IOP by Improved Drainage through the Ciliary Muscle

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## INTRODUCTION

The ciliary muscle CM serves three important functions, all of which contribute to IOP. 1) It is a key component in accommodation; 2) It is the first structure along the pathway of uveoscleral drainage of aqueous humor and it provides resistance to this drainage; 3) It connects to the scleral spur and when contracted it maintains patency of the collapsible Schlemm's canal (SC) to directly affect trabecular outflow facility.

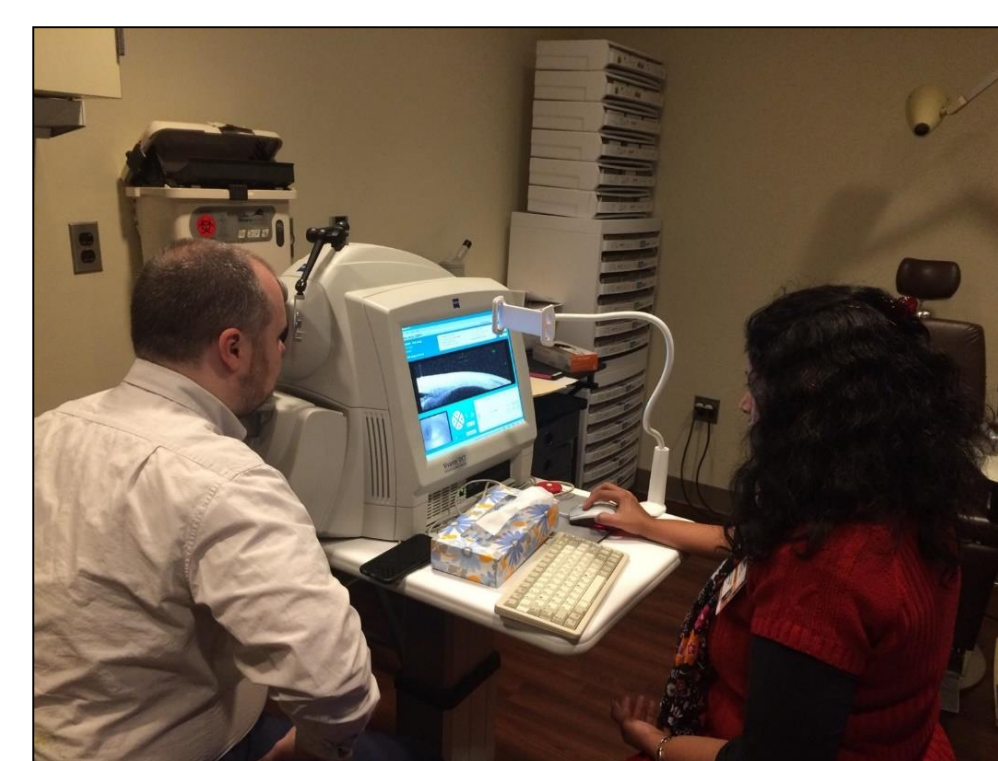
Our working hypothesis is that the CM mediates resistance in the aqueous humor drainage pathways by way of its dynamic movements as it maintains various accommodative states. Thus voluntary CM contractions and relaxations should facilitate outflow through the uvea as well as the trabecular meshwork and lower IOP voluntarily.

## METHODS

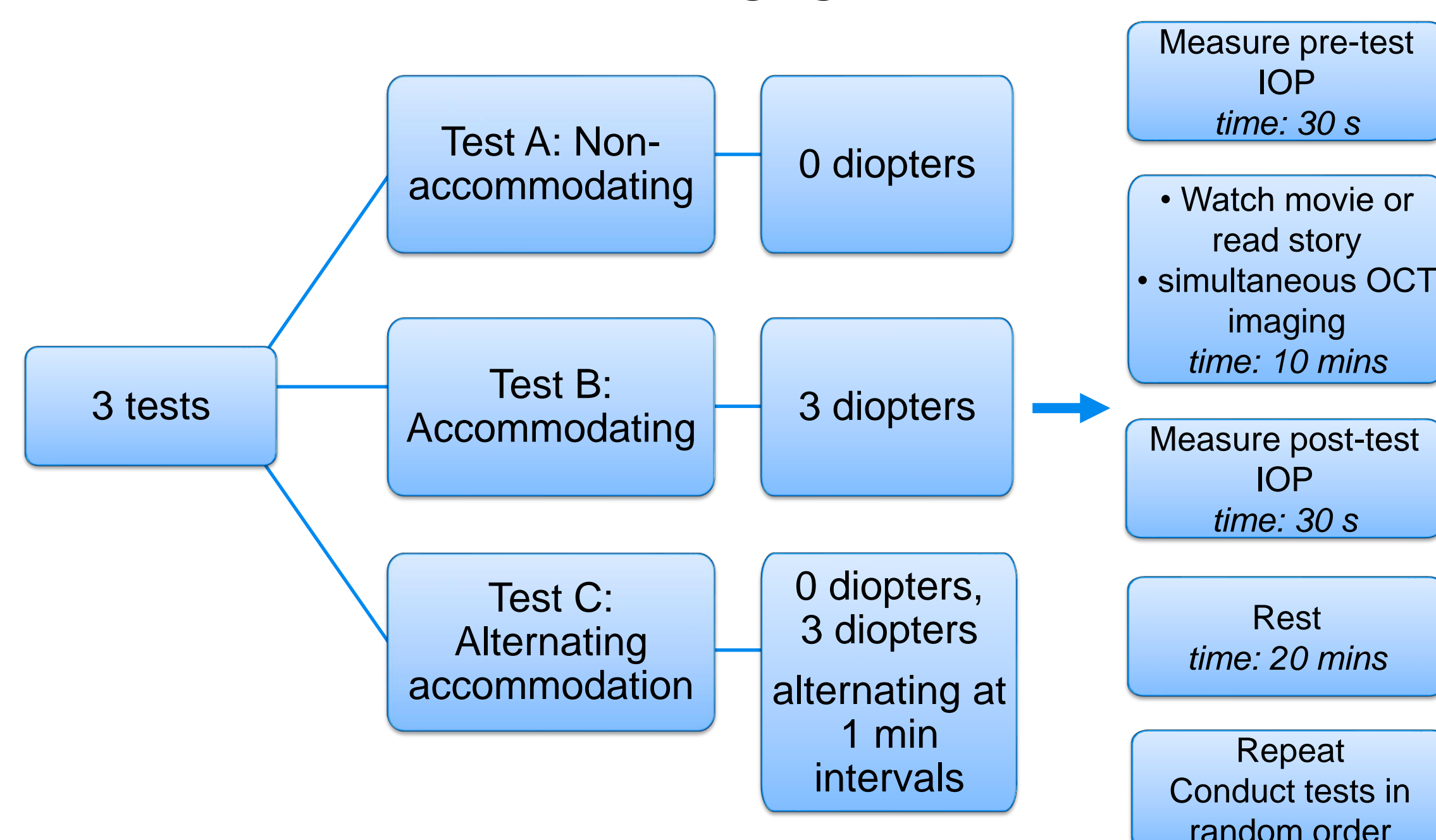
### GROUPS

Volunteers	Age range (years)	Race	N=35
Young group	20-25	Asian	2
		Black	1
		White	9
TOTAL			12
Middle group	40-49	Asian	2
		Black	4
		White	4
TOTAL			10
Old group	61-68	Black	9
		White	4
		TOTAL	

### OCT SETUP



### TESTS



## MEASUREMENTS

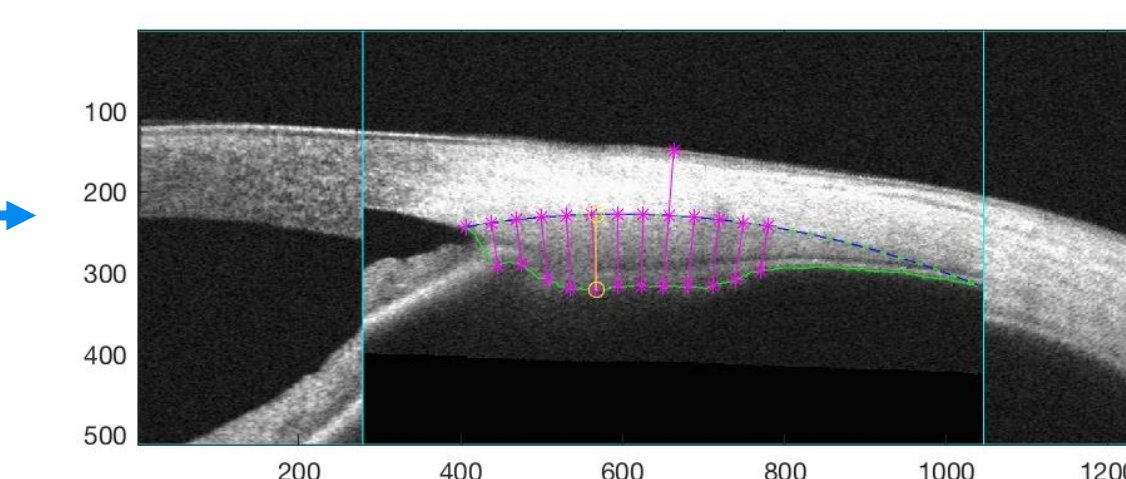
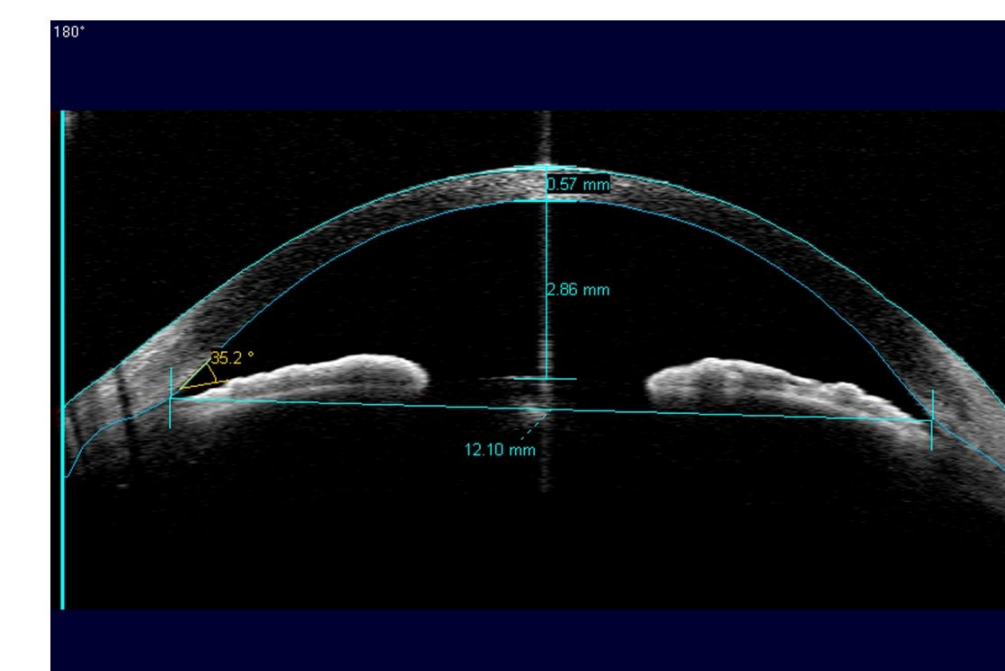
Grand Seiko Autorefractor  
pupil size and refraction while accommodating or nonaccommodating

Zeiss Cirrus OCT  
anterior chamber depth, angle, central cornea thickness

Zeiss Cirrus OCT  
Ciliary muscle thickness while accommodating or nonaccommodating

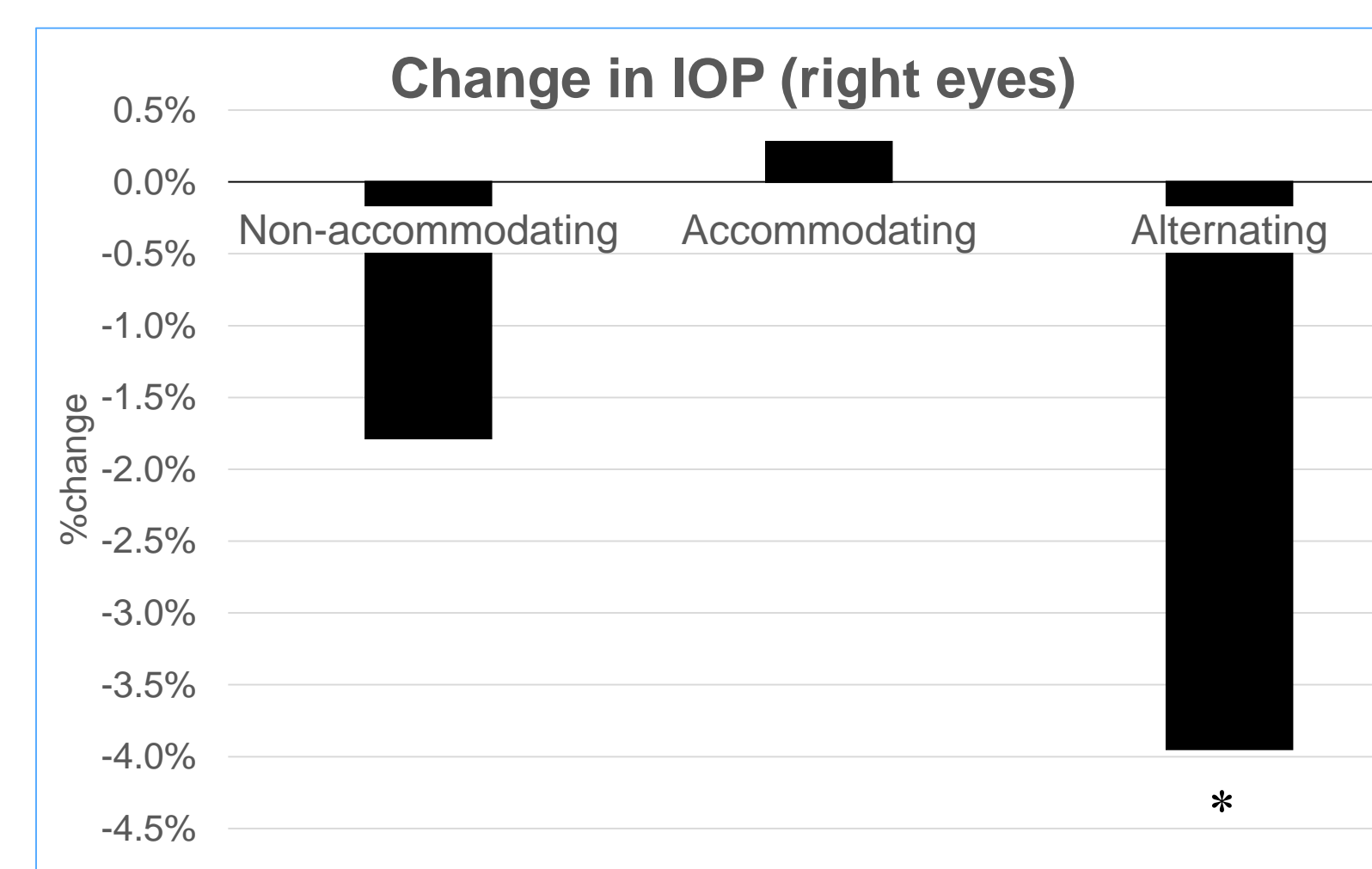
Classic 30 pneumatonometer  
Six sets of IOPs

Groups and tests were randomized and masked.



## RESULTS

When comparing pre-test IOP to post-test IOP, IOP was significantly lower in all age groups with the alternating accommodation test (18.43 vs 17.69 mmHg,  $p = 0.029$ ). This was a -4.0% reduction.



Consistent with established literature, the pupil size was smaller on accommodation and in older subjects.<sup>1</sup>

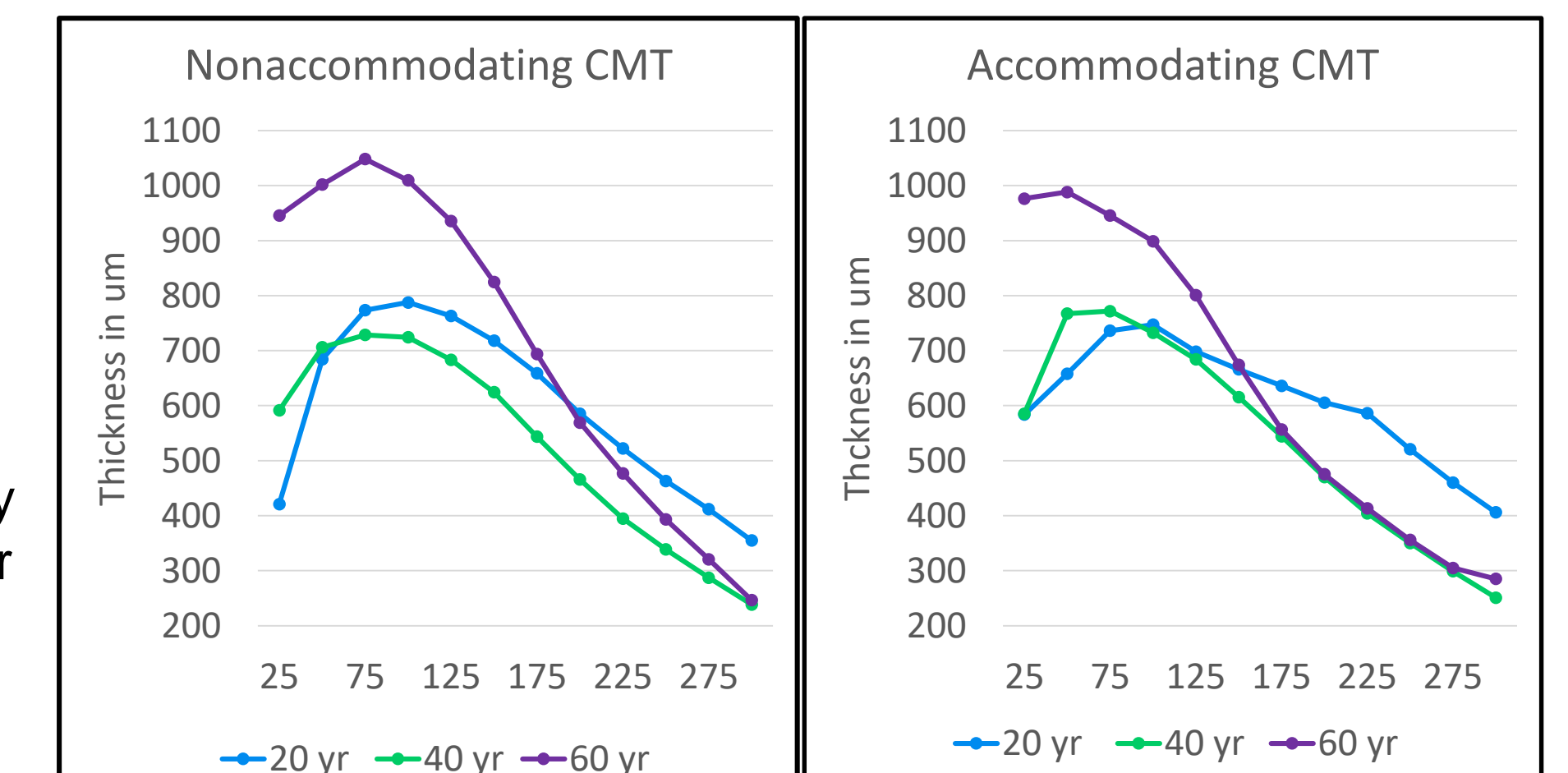
Group	Pupil diameter (mm)			
	OD		OS	
	Near	Far	Near	Far
20 yo	6.7	7.0	5.9	6.4
40 yo	4.4	5.0	4.0	4.8
60 yo	4.5	4.9	4.3	4.7
total	5.3	5.6	4.6	5.1

The 60 year old age group had a significantly shorter AC depth, and significantly narrower angle. This was consistent with established literature.<sup>2</sup>

Group	Ocular biometrics			
	CCT (mm)	AC depth (mm)	AC diameter (mm)	angle
20 yo	0.57	3.22 <sup>a</sup>	12.08	46.2 <sup>a,b</sup>
40 yo	0.56	2.92	12.05	37.8
60 yo	0.54	2.67	11.94	34.5

## RESULTS

60 yo subjects had thicker ciliary muscles (CMT) close to the scleral spur, and thinner ciliary muscles away from the scleral spur compared to the 20 yo group.



## CONCLUSIONS

As we age,

- the pupils become smaller
- the anterior chamber depth gets smaller
- the anterior chamber angles narrow
- the ciliary muscle thickens anteriorly

With alternating accommodation

- The IOP can be lowered.
- Aging does not make a difference.
- The ciliary muscle in the left eye changes little while the right eye accommodates.<sup>3</sup>

## NEXT STEPS

- Prepare R01 grant on The role of the ciliary muscle in drainage of aqueous humor.
- Test ocular hypertensive or glaucoma patients.
  - Change the timing of exercise and/or recovery period to maximize IOP effect.
  - Increase the workload (4 diopters of power) on the eye.
  - Answer the question of whether it is possible to time the exercises so that a healthy IOP can be maintained throughout the day.
- Test patients before and after cataract surgery.

## ACKNOWLEDGEMENTS

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## REFERENCES

1. Birren, J. E., Casperson, R. C., & Botwinick, J. (1950). Age changes in pupil size. *Journal of Gerontology*, 5(3), 216-221.
2. Fontana, S. T., & Brubaker, R. F. (1980). Volume and depth of the anterior chamber in the normal aging human eye. *Archives of Ophthalmology*, 98(10), 1803-1808.
3. Marran, L., & Schor, C. M. (1998). Lens induced aniso-accommodation. *Vision research*, 38(22), 3601-3619.