

# STUDY OF BIOMECHANICAL PARAMETERS OF CORNEOSCLERAL EYE SHELL IN CHILDREN WITH PROGRESSIVE MYOPIA USING OCULAR RESPONSE ANALYZER

Elena Iomdina, Zhanna Ivashchenko, Margarita Eremina, Elena Tarutta, Nino Kvaratskheliya

*Moscow Helmholtz Research Institute of Eye Diseases, Russia*

*iomdina@mail.ru, zhaniv@mail.ru, tarutta@sumail.ru*

Poster #20

## INTRODUCTION:

Current views assume that damaged supportive (biomechanical) properties of the corneoscleral eye shell is the most important factor of myopia progression.

## AIM:

To study biomechanical parameters of the corneoscleral eye shell in children with progressive myopia and assess their change after sclera reinforcement procedure.

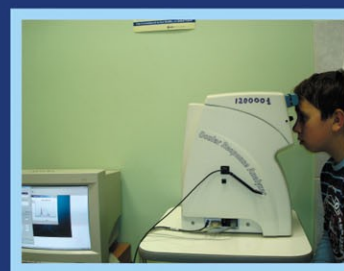


## METHODS:

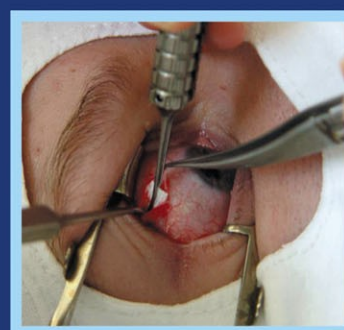
A new device, Ocular Response Analyzer (ORA) by Reichert Ophthalmic Instruments (USA) is used to evaluate the biomechanical properties of the cornea as a viscoelastic material and to refine IOP measurements.

In our study, ORA was used to examine 57 eyes of patients aged 7-18, including:

- 8 emmetropic and low hyperopic eyes (control group)
- 11 eyes with low myopia (-0.5 to -3.0 D)
- 11 eyes with moderate myopia (-3.25 to -6.0 D)
- 16 highly myopic eyes (-6.25 to -12.0 D)
- 11 patients aged 9-16 with progressive myopia from -4.75 to -7.25 D before and 1-3 months after low invasive sclera reinforcement procedure made using a biologically active synthetic material.



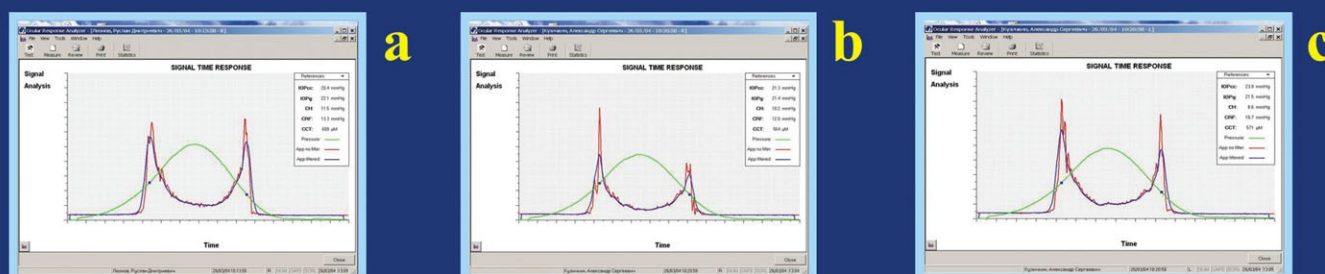
Measuring intraocular pressure (IOP by Goldman and corneal compensated IOP) and biomechanical parameters (corneal hysteresis and the factor of corneal resistivity) in a myopic child.



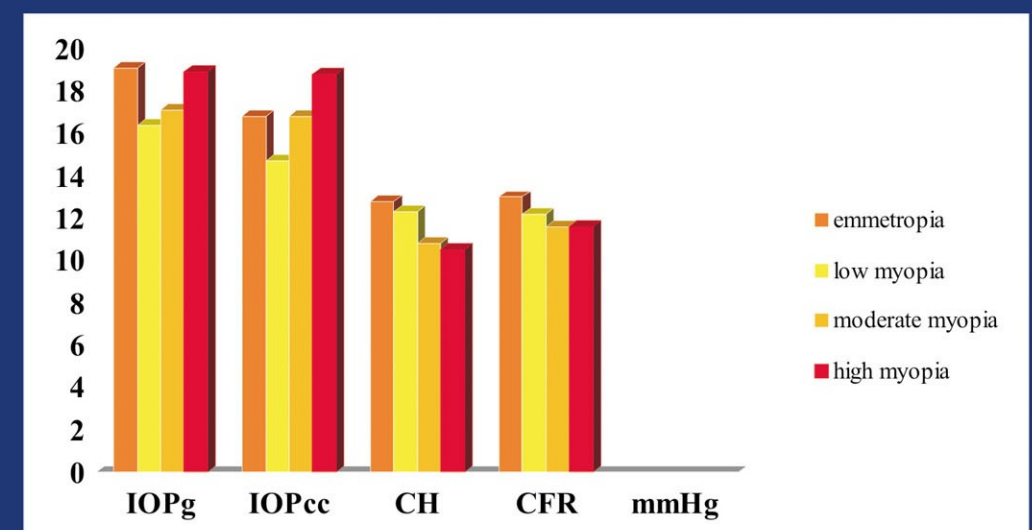
Biologically active synthetic graft is a promising means for effective scleroplastic reinforcing treatment of progressive myopia.

## RESULTS:

Corneal hysteresis (CH) proved to be lower in moderate ( $10.8 \pm 0.4$  mmHg) and high myopia ( $10.5 \pm 0.3$  mmHg) than in emmetropia ( $12.8 \pm 1.0$  mmHg) and low myopia ( $12.3 \pm 0.2$  mmHg).

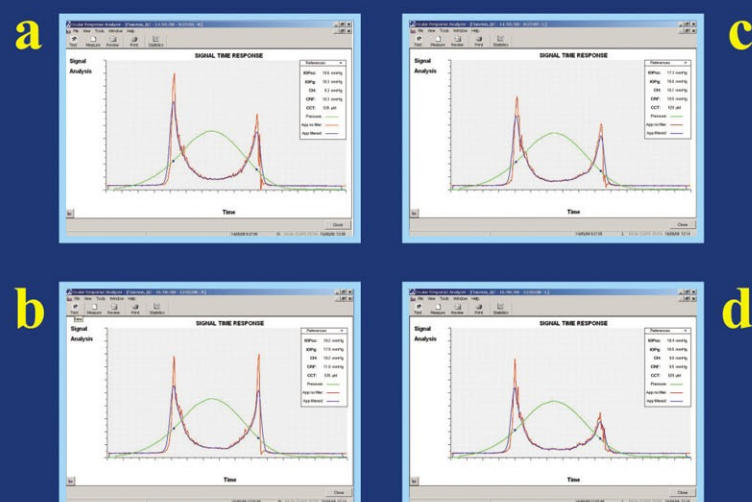


ORA measurement in low (a), moderate (b) and high (c) myopia



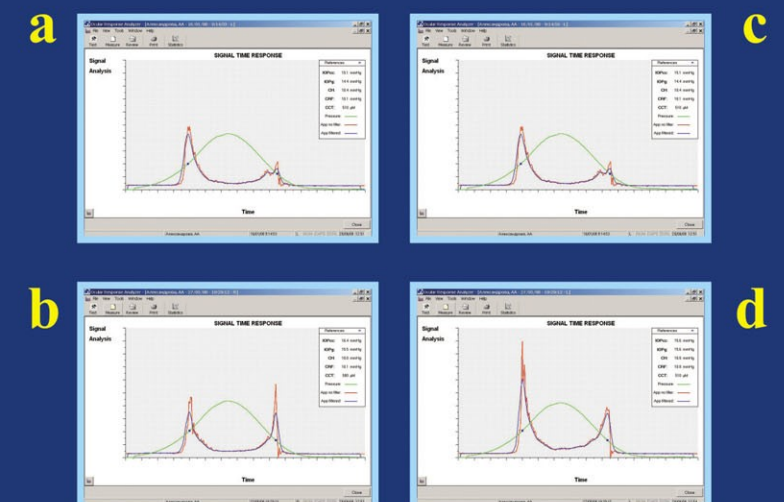
IOP and biomechanical parameters of the corneoscleral shell of children with different clinical refraction.

1 month after sclera reinforcement procedure, an increase of CH to  $12.5 \pm 0.7$  mmHg was noted; 3 months later CH was somewhat lower.



ORA measurement in operated eye before (a) and 1 month after (b) surgery, in fellow intact eye before (c) and after (d) surgery

ORA measurement in operated eye before (c) and 3 months after (d) surgery, in fellow intact eye before (a) and after (b) surgery



Another ORA parameter, the factor of corneal resistivity, has not revealed any statistically valid link with clinical refraction in examined children.

## CONCLUSION:

- Biomechanical parameters of corneoscleral shell of myopic eye differ from those of emmetropic eyes.
- Decrease of CH in moderate and high myopia and increase of CH after a sclera reinforcement procedure validate the hypothesis that this parameter is relevant for biomechanical properties for both the cornea and the sclera.
- Further studies in this direction are required to verify the obtained data and evaluate their clinical and diagnostic relevance for patients with progressive myopia.

# EFFECT OF IRIFRINI (PHENYLEPHRINE) ON THE DARK FOCUS OF ACCOMMODATION IN CHILDREN WITH MYOPIA

Elena Tarutta, Elena Iomdina, Oksana Filinova, Nino Kvaratskheliya

*Moscow Helmholtz Research Institute of Eye Diseases, Russia*

*tarutta@sumail.ru, iomdina@mail.ru*

Poster #42

**INTRODUCTION:**

Irifrin (Phenylephrine) is a sympathomimetic, which has expressed alpha-adrenomimetic activity. When administered in regular doses, it does not stimulate the central nervous system. Instillations of irifrin cause pupillary dilatation, an increase of aqueous humor outflow and constriction of conjunctival vessels. Due to its sympathomimetic properties, irifrin may be expected to decrease the tonus of accommodation (or increase negative accommodation).

**AIM:**

To study the effect of irifrin on dynamic refraction, objective accommodation and dark focus of accommodation in myopic children.

**METHODS:**

16 children (32 eyes) aged 7-15 with myopia from -0,18 до -6,5 D were examined noncycloplegic refraction at the distance of 5 m, refraction under full correction at the distance of 33 cm (accommodation response) and dark focus were measured using a binocular open-field autorefractometer/ keratometer Grand Seiko WR-5100K (Fig 1).The dark focus was determined in complete darkness. Illuminated parts of the device were covered so that they could not affect the patient. Each eye was examined 5 – 10 sec. after the light had been switched off so as to eliminate the impact of dark adaptation. All examinations were performed twice: before a 4-week course of daily instillations of 2,5% irifrin solution and immediately after it.

**RESULTS:**

Prior to irifrin instillations, noncycloplegic refraction at 5 m was -2,34±0,52 D; in complete darkness -2,82±0,49 D; accommodation response at 33 cm -1,96±0,45 D. After irifrin instillations, the objective noncycloplegic refraction with the object fixed at a distance of 5 m fell to 2.02±0.54 D to show a 0.32 D reduction, while the accommodation response grew 0,22 D to reach -2.18±0.45 D. The dark focus of accommodation fell 0.29 D to -2.53±0.31 D. No statistically significant difference with the initial level could be revealed, probably to an insufficient number of tests (Table 1).

**CONCLUSION:**

The obtained data evidence a changed balance of vegetative innervation: a reduction in parasympathic innervatio and a slight increase of sympathetic innervation. The study should be continued with more patients involved.



**Fig.1**  
**ACCOMMODATION RESPONSE AT 33 CM**

**Table 1**  
**CHANGE OF DYNAMIC REFRACTION, OBJECTIVE ACCOMMODATION AND DARK FOCUS DURING 4-WEEK PERIOD.**

Time of examination	Number of eyes	Noncycloplegic refraction at the distance of 5 m, D	Dark focus, D	Accommodation response, D
Start of follow-up period	32	-2,34±0,52	-2,82±0,49	-1,96±0,45
End of follow-up period	32	-2,02±0,54	-2,53±0,31	-2,18±0,45

# RESULTS OF FUNCTIONAL TREATMENT OF PROGRESSIVE MYOPIA USING LOW INTENSIVE TRANS-SCLERAL LASER STIMULATION, INFRASOUND PNEUMATIC MASSAGE AND 2.5% IRIFRIN SOLUTION INSTILLATIONS

Elena Tarutta<sup>1</sup>, Elena Iomdina<sup>1</sup>, Nina Kushnarevich<sup>1</sup>, Leonid Orbachevsky<sup>2</sup>

*Helmholtz Research Institute of Eye Diseases<sup>1</sup>, MACDEL-Technologies<sup>2</sup>, Moscow, Russia*  
*tarutta@sumai.ru, iomdina@mail.ru, LS-macdel@tochka.ru*

Poster #43

## INTRODUCTION:

The improvement of hemodynamic and accommodation parameters noted after low intensive trans-scleral laser stimulation course (with MACDEL-09) accounts for the positive effect of the treatment on the myopic process and justifies the use of the method for the functional therapy of progressive myopia (E.Tarutta et al., 2006). It was shown that cardioimpulse infrasound pneumatic massage also improves accommodation capacity and contributes to disappearance of asthenopic symptoms in patients with refractive anomalies (E.Iomdina et al., 2005, 2006). Irifrin (Phenylephrine) as a sympathomimetic may be expected to decrease the tonus of accommodation (or increase negative accommodation).

## AIM:

To estimate the results of functional treatment of progressive myopia using low intensive laser stimulation of the ciliary area in combination with infrasound pneumatic massage and 2.5% irifrin (phenylephrine) solution instillations.

## METHODS:

63 patients aged 9-18 with progressive myopia from -0.75 to -8.0 D and accommodation disorders were examined prior to the treatment course and at different times after it. In addition to regular clinical examinations, we measured absolute accommodation volume (AAV) and critical flicker-fusion frequency (CFF) to color stimuli (red, blue and green), which characterizes the temporal contrast sensitivity of the eye. Fig. 1, 2, 3, 4, 5.



Fig.1. Measuring absolute accommodation volume (AAV).



Fig. 2. A device for measuring critical flicker-fusion frequency (CFF) to color stimuli (red, blue and green) – Blick 5.  
Frequency of light stimulus flickers: 5– 60 Hz  
Frequency variation step: 0.5 Hz  
Maximum power of the light pulse: 0.8 micro candles  
Light diodes: red, blue, green



Fig. 4.  
A treatment procedure using MACDEL-09.



Fig. 3.  
A device for low intensive trans-scleral laser stimulation of the ciliary muscle - MACDEL-09.



Fig. 5, 6.  
2% phenylephrine solution (irifrin) was instilled immediately before each pneumatic massage procedure.

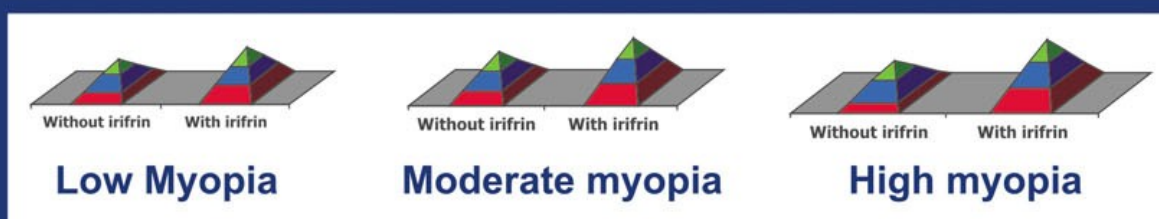


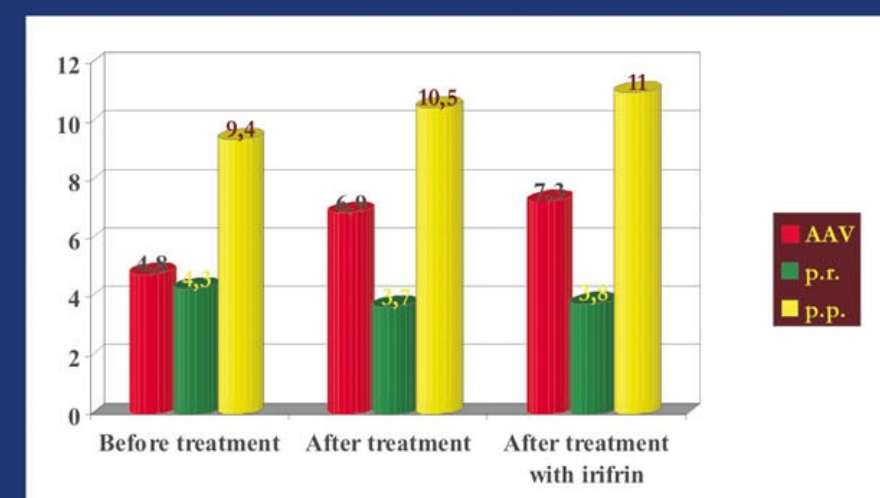
Fig. 8. The increase of CFF on color stimuli (red, blue and green) after functional treatment.

## RESULTS:

After the treatment AAV increased in low myopia by 2.9 0.3 D, in moderate myopia by 1.4 0.2 D and in high myopia by 1.2 0.2 D (Fig.7). CFF on all stimuli also increased by 8.8-9.3%, especially on green stimuli (Fig.8). A slowdown of myopia progression during 2 years was noted in 72% of cases.

The increase of AAV after functional treatment.  
CFF on all stimuli also increased by 8.8-9.3%, especially on green stimuli (Fig.7).  
A slowdown of myopia progression during 2 years was noted in 72% of cases.

Fig. 7.



## CONCLUSION:

Combined functional treatment improves the performance of the ciliary muscle and affects favorably the discriminating facilities of the retina in children with progressive myopia, which contributes to the inhibition of myopia progression.

# MEDICAL AND SOCIAL ANALYSIS OF PATIENTS WITH ACQUIRED MYOPIA TREATED IN THR ORENBURG REGIONAL CLINICAL HOSPITAL

Alexander Aprelev<sup>1</sup>, Zhanna Ivashchenko<sup>2</sup>

Poster #47

*Orenburg Regional Clinical Hospital No 1<sup>1</sup>,  
Moscow Helmholtz Research Institute of Eye Diseases<sup>2</sup>, Russia*

**AIM:** To estimate the parameters of the myopic condition that affect its development and treatment outcome.

## MATERIAL AND METHODS:

Medical histories of 553 patients with acquired myopia aged 14-60 who were treated in the Orenburg Regional Clinical Hospital No 1 in 1999-2003 were analyzed (Table 1).

The following parameters were taken into account:

- patient's age
- myopia degree
- treatment duration (in days)
- stable or progressive course of the disease
- social status, town/country residence
- condition of eye media and the fundus
- associated eye diseases
- visual acuity before and after hospital treatment

## RESULTS:

- The earlier the age of disease onset, the higher the degree of myopia (Fig.1, Fig.2).
- The myopia onset occurs somewhat earlier in urban areas:  $9.98 \pm 0.35$  yrs than in rural areas:  $10.47 \pm 0.27$  yrs (Fig. 3).
- Retired people had the longest treatment duration:  $10.47 \pm 0.25$  days (Table 2).
- Patients with uncomplicated progressing clinical course had shorter duration treatment ( $6.49 \pm 0.12$ ,  $p < 0.05$ ) than patients with stable complicated clinical course ( $9.1 \pm 0.15$  days) (Fig. 4, Fig.5).
- The higher the degree of myopia, the more expressed the myopic cone and the higher the frequency of myopia complications (Fig. 6).
- The higher the degree of myopia, the greater the extent of eye stretch and the lesser the transparency of eye media (Table 3).
- There is no significant difference between visual acuity before and after hospital treatment (Table 4).

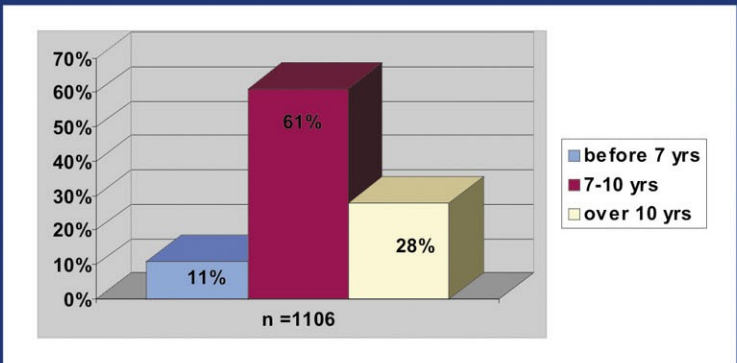


Fig. 1. Distribution of patients according to the age of myopia onset

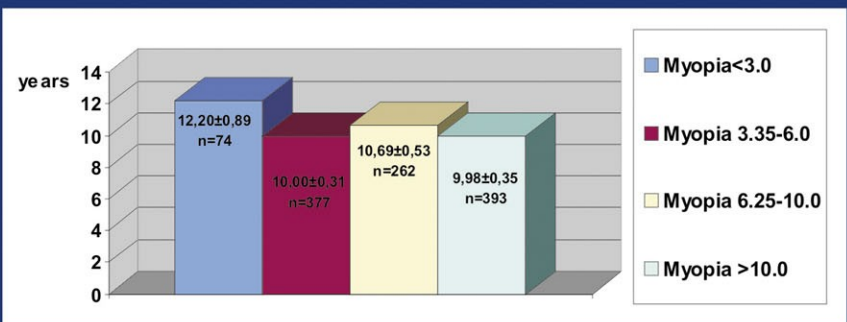


Fig. 2. The mean age of the onset of myopia of different degrees.

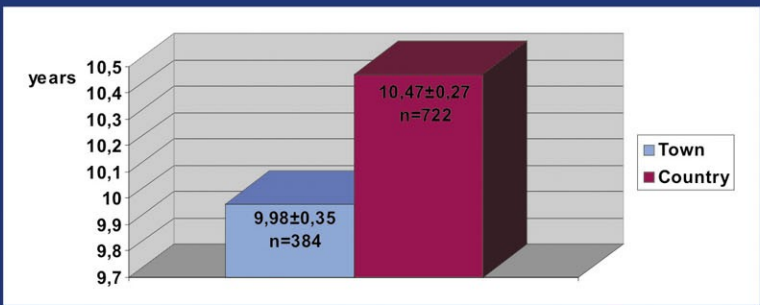


Fig. 3. Age of myopia onset in patients living in towns and country areas

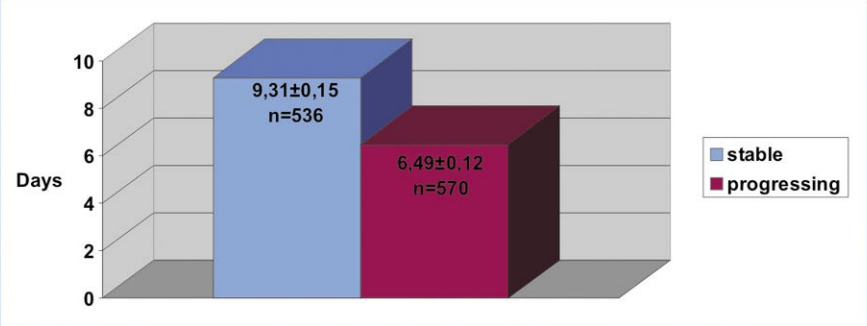


Fig. 4. Treatment duration in patients with uncomplicated progressing clinical course and patients with stable complicated clinical course

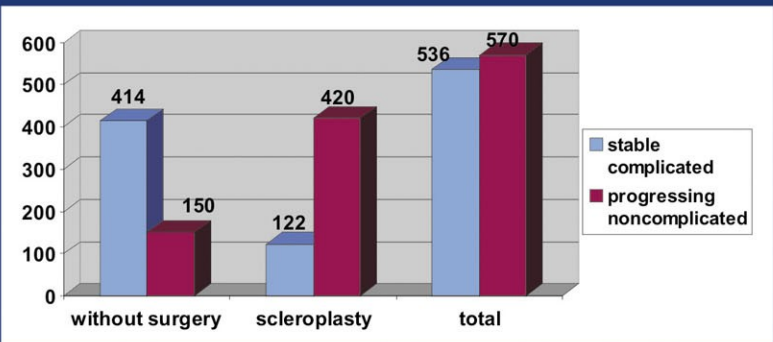


Fig. 5. The number of scleroplastic surgeries in patients with uncomplicated progressing clinical course and patients with stable complicated clinical course.

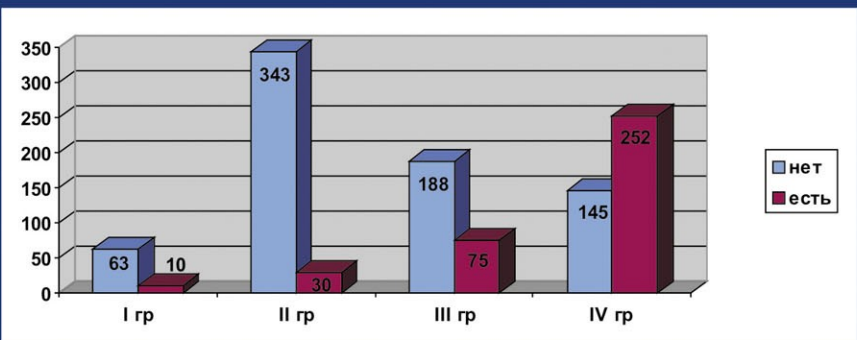


Fig. 6. The number of patients with retinal dystrophy (%) depending on myopia degree

Table 1.  
Distribution of patients according to their age and sex

	sex	Age group						Total
		under 20 ys	21-30 ys	31-40 ys	41-50 ys	51-60 ys	post 60 ys	
Number of patients	f	178	46	34	43	60	48	409
Percentage		32.2%	8.3%	6.1%	7.8%	10.8%	8.7%	73.9%
Number of patients	m	71	26	16	14	10	7	144
Percentage		12.8%	4.7%	2.9%	2.5%	1.8%	1.3%	26.0%
Total		249	72	50	57	70	55	553

Table 2.  
The difference between social groups by age of myopia onset and inpatient treatment duration

Social group	Number of cases	Age of myopia onset, yrs M±m	Treatment duration, bed-days M±σ
High school students	482	8,96±0,14	6,46±2,61
College students	112	10,20±0,38	6,23±3,35
Employees	156	10,53±0,57	9,28±3,93
Workers	186	11,11±0,65	9,04±2,75
Retired people	170	13,08±0,93	10,28±3,10
Total	1106	10,30±0,21	7,86±3,40

Table 3.  
Parameters of media transparency and axial length in patients with myopia of different degrees

Myopia degree	Number of eyes	Parameter of media transparency, relative units (M±m)	Axial length, mm M±σ
Till 3,0 D	74	0,02±0,07	25,09±0,84
3,25-6,0 D	377	0,03±0,01	25,40±1,08
6,25-10,0 D	262	0,16±0,03	27,30±1,20
More than 10,0 D	393	0,36±0,03	28,89±0,72
Total	1106	0,19±0,02	27,07±1,84

Table 4.  
Visual acuity and refraction before and after treatment of myopic patients in hospital conditions (mean 7.85 bed-days)

Parameters	Before treatment M±σ	After treatment M±σ
UCVA	0.13±0.18	0.14±0.19
BCVA	00.49±0.36	0.51±0.36
Refraction, D	9.71±5.86	9.63±5.82

## CONCLUSION:

1. The majority of myopic patients are female (72.9% female vs 27.1% male)
2. The earlier the age of disease onset, the higher the degree of myopia.
3. In 72% of patients, myopia emerged before the age of 10.
4. The difference between the age of myopia onset in the studied social groups was significant ( $p < 0.05$ ) for groups of workers ( $11.13 \pm 0.65$  yrs) and high school students ( $8.96 \pm 0.14$  yrs).
5. The age of myopia onset is certainly lower in urban areas ( $9.98 \pm 0.35$  yrs) than in rural areas ( $10.47 \pm 0.27$  yrs).
6. The duration of treatment was shorter in groups of high school and college students ( $6.46 \pm 0.12$  and  $6.23 \pm 0.32$  days, resp.) than in retired people ( $10.28 \pm 0.24$  days), because of a concurrent pathology ( $p < 0.05$ )
7. The higher the degree and duration of myopia, the longer the antero-posterior axis, the higher the frequency of chorioretinal dystrophies and the lesser the transparency of eye media ( $r = 0.601$ )
8. There is no significant difference of functional parameters of myopic patients measured after treatment as compared to those measured before treatment. Further study and development of new combined therapeutic methods of myopia treatment is needed.

# A LONGITUDINAL CASE STUDY OF A SEVERE MYOPE WITH ACQUIRED ESOTROPIA

Carol S.F. Wong

School of Optometry, The Hong Kong Polytechnic University, Hong Kong

Poster #48

**INTRODUCTION:** High myopic patients were reported to suffer from acquired esotropia with their elongated eyeballs. The acquired esotropia in high myopes was caused by the compression of lateral rectus between the enlarged eyeball and the orbital wall.<sup>1,2</sup> This reflects that the excessive elongation of eyeball may limit ocular motility and affect binocular vision.

**AIM:** To investigate the progression of the acquired esotropia in a severe myope.

**METHOD:** A two-year longitudinal case study.

**RESULTS:** A 58-year-old male presented with binocular horizontal diplopia which had onset for 3 years. Except mild cataract and peripheral retinal laser treatment in both eyes, his ocular health and general health were unremarkable. His ocular findings are summarized in Table 1. His magnitude of acquired left esotropia (Figure 1) was increased, subsequent left hypotropia was developed and axial length was increased in both eyes within 2 years. Hess screen revealed the underaction of lateral rectus in both visits (Figure 2).

	First visit (age of 58)	Second visit (age of 60)
Refraction	OD: -15.50/-0.75Dx80 VA 6/9 OS: -19.00/-1.00Dx90 VA 6/9	OD: -16.50/-0.75Dx50 VA 6/9 OS: -19.25/-0.50Dx165 VA 6/9
Cover test	Distant: acquired intermittent 25 $\Delta$ left esotropia (frequency 90%) Near: 6 $\Delta$ esophoria	Distant: acquired constant 25 $\Delta$ left esotropia and 4 $\Delta$ left hypotropia Near: acquired constant 12 $\Delta$ left esotropia and 4 $\Delta$ left hypotropia
Hess screen	Underaction of lateral rectus in left eye	
Bagolini striated lens test (photopic)	Uncrossed diplopia at 40 cm and 3 m; left eye suppressed at 6m	Uncrossed diplopia at 40 cm; left eye suppressed at 3m and 6m
Axial length	OD: 32.11 mm OS: 33.69 mm	OD: 32.35 mm OS: 33.86 mm
Treatment	Fresnel prism was prescribed to neutralize diplopia	

Table 1: Ocular findings summary of the patient.



Figure 1: Left esotropia in the second visit.

**DISCUSSION:** High myopia is an uncommon etiology of acquired tropia. It is a form of mechanical tropia in which excessive enlargement of the high myopic eyeball produces pressure on extraocular muscles and limits their movements in the fixed orbital cavity.

Lateral rectus is more vulnerable because of its anatomical structure.<sup>1</sup> It was compressed between the enlarged eyeball and the orbital wall as shown by the computed tomography in esotropic high myopes.<sup>1,2</sup>

Another study suggested that there was superiotemporal dislocation of the excessive elongated eyeball in severe myopes due to the lack of supporting muscle at the superiotemporal quadrant of the extraocular muscular cone. Lateral rectus was shifted inferiorly, superior rectus was displaced nasally and the eye became esotropic and hypotropic.<sup>3</sup>

These explain our observations in the increased acquired esotropia and subsequent hypotropia resulted from the elongated eyeball.

**CONCLUSION:** The progressive elongation of eyeball in this case induced progressive esotropia and subsequent hypotropia. This indicates that the enlarged eyeball in severe myope limits the lateral rectus and other extraocular muscles which control vertical eye movement. High myopia should be considered as one of the etiologies for both acquired horizontal and vertical ocular deviations.

**REFERENCES:**

1. Bagolini B, Tamburrelli C, Dickmann A, Colosimo C. Convergent strabismus fixus in high myopic patients. *Doc Ophthalmol* 1990;74:309-320.  
2. Kaynak S, Durak I, Özaksoy D, Canda T. Restrictive myopic myopathy: computed tomography, magnetic resonance imaging, echography, and histological findings. *Br J Ophthalmol* 1994;78:414-415.  
3. Yokoyama T, Tabuchi H, Ataka S, Shiraki K, Miki T, Mochizuki K. The mechanism of development in progressive esotropia with high myopia. *Transactions of the 26th meeting, European Strabismological Association*. Barcelona, Spain: Swets & Zeitlinger Publishers; 2000:218-221.

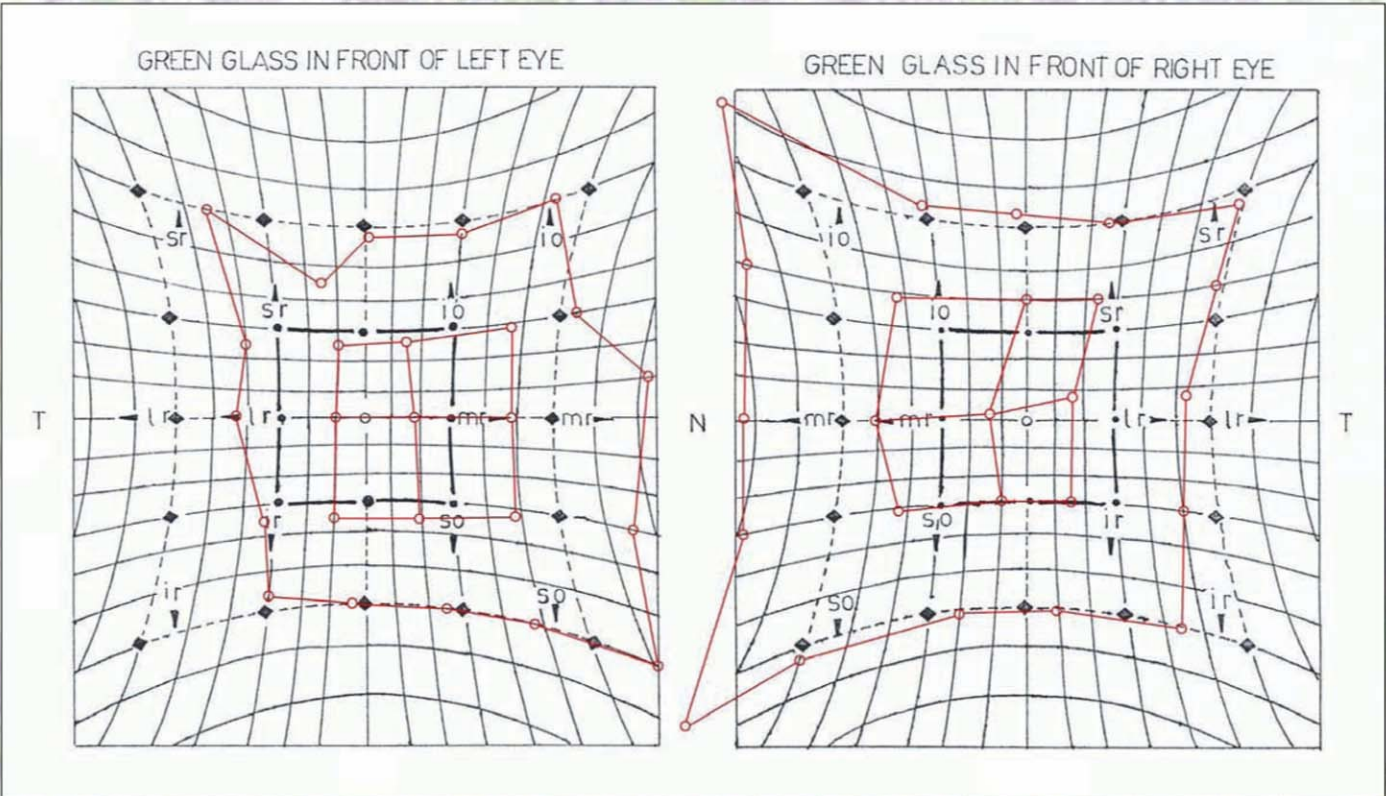


Figure 2: Hess screen result in the second visit.