The art of choosing rational optical correction using the eyeglasses and contact lenses of modern design in the light of the metabolic theory of adaptive myopia

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Reference point. Difficult questions.

1. The acquired myopia is a disease or adaptation.
2. What physiological mechanisms and visual loads lead to the development of adaptative myopia in human and animal eyes.
3. Do we have an effective generally accepted theory of adaptative myopia (AM)?
4. Do we have an objective criteria for safe video loads?
5. Which country had developed state regulations on the safety of visual work in the era of display civilization and artificial light sources.

We will try to answer all these questions.

Reference point.

- Until this day there is no generally accepted theory of adaptive myopia. Safety criteria for visual workloads are not developed. This does not allow to successfully combat adaptive myopia.

- Number of people with adaptive myopia is growing rapidly all over the world. By 2050 there will be 5 billion people affected by myopia. In fact, we are facing the pandëemic of myopia.

- We struggle with the aftermath and not with the cause of adaptive myopia.

Our point of view.

- **Adaptive myopia** is not a disease, but a common for humans and animals physiological mechanism of eyes length adaption to the prolonged loads in individual visual environments.

- **Adaptive myopia** is the classical case of the predominance of accommodation by outflow.

The goal of the normal Adaptive myopia (AM)

1. All biological systems on Earth are developed according to ***the principle of energy conservation*** – It is the fundamental principle of adaptation to the environment.
2. The main goal is ***to reduce the energy consumption*** of the eye during prolonged intensive visual work.

Examples.

Animals. Highly developed monkeys, living by collecting and looking at small objects. Cats and dogs in conditions of limited space often have myopia.

People. Marines who serve on nuclear submarines often develop myopia due to long-term tenure in closed environments where space is limited.

The military and civilian pilots often become myopic in 35-45 years due to intensive work with displays in the dark and confined space cabin.

Myopia is often observed among accountants and bank employees.

The goal of the normal Adaptive myopia (AM)

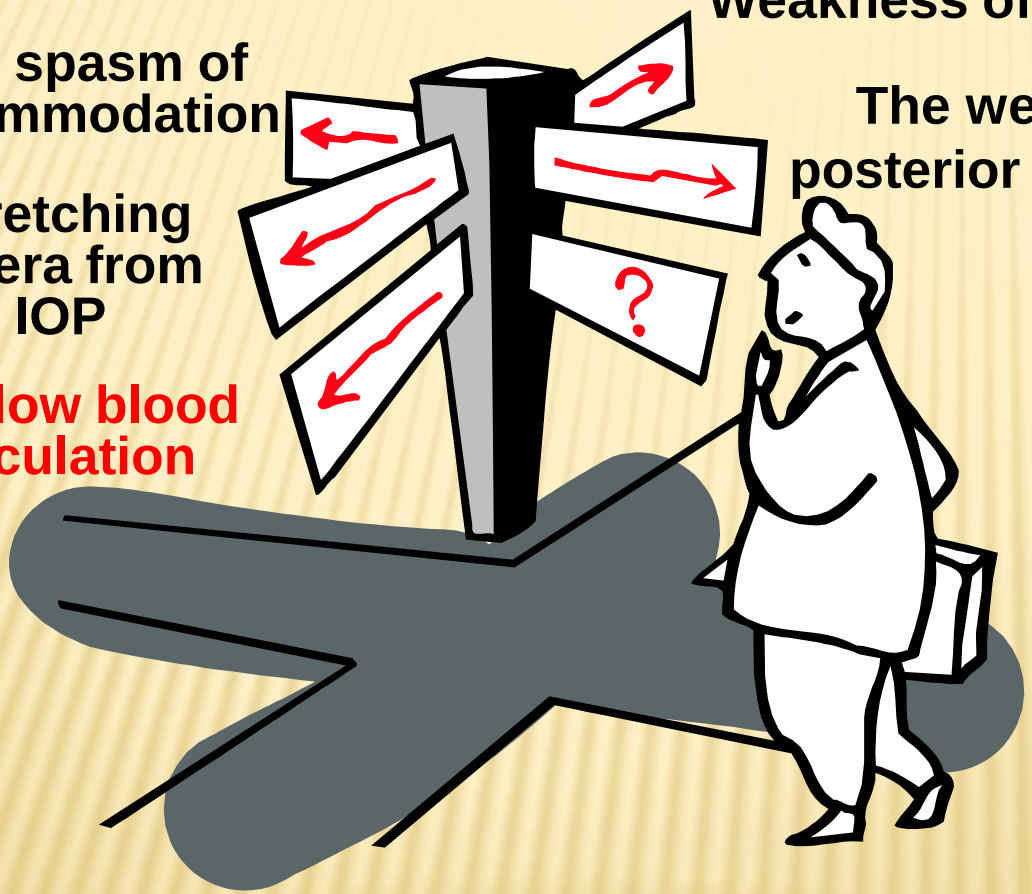
2. The second goal of the development of the AM - to adjust to visual habitat at close distance to ensure *the visual comfort*, improve competitiveness and survival of the species.

AM develops in children and adults!

This important finding is confirmed by many researches:

- ✓ 35% of healthy employees of our company "Vodokanal of St. Petersburg", have developed myopia of a weak degree after 5 -7 years due to work with the computer for about 8 hours per day.
- ✓ When working with the microscope, the staff develops unilateral myopia.
- ✓ The Inuit of North America have myopia above 1.0 (D) aged 21 to 25 years after often use of displays.
- ✓ However, the Inuit of North America over 50 years do not have myopia, because their visual load at close distances is minimal. **When there is no cause – there is no adaptation and there is no myopia!**

What is the reason for *«the optical defiance of the eye and is often not at all a disease»?* (E.S. Avetisov, 2001)

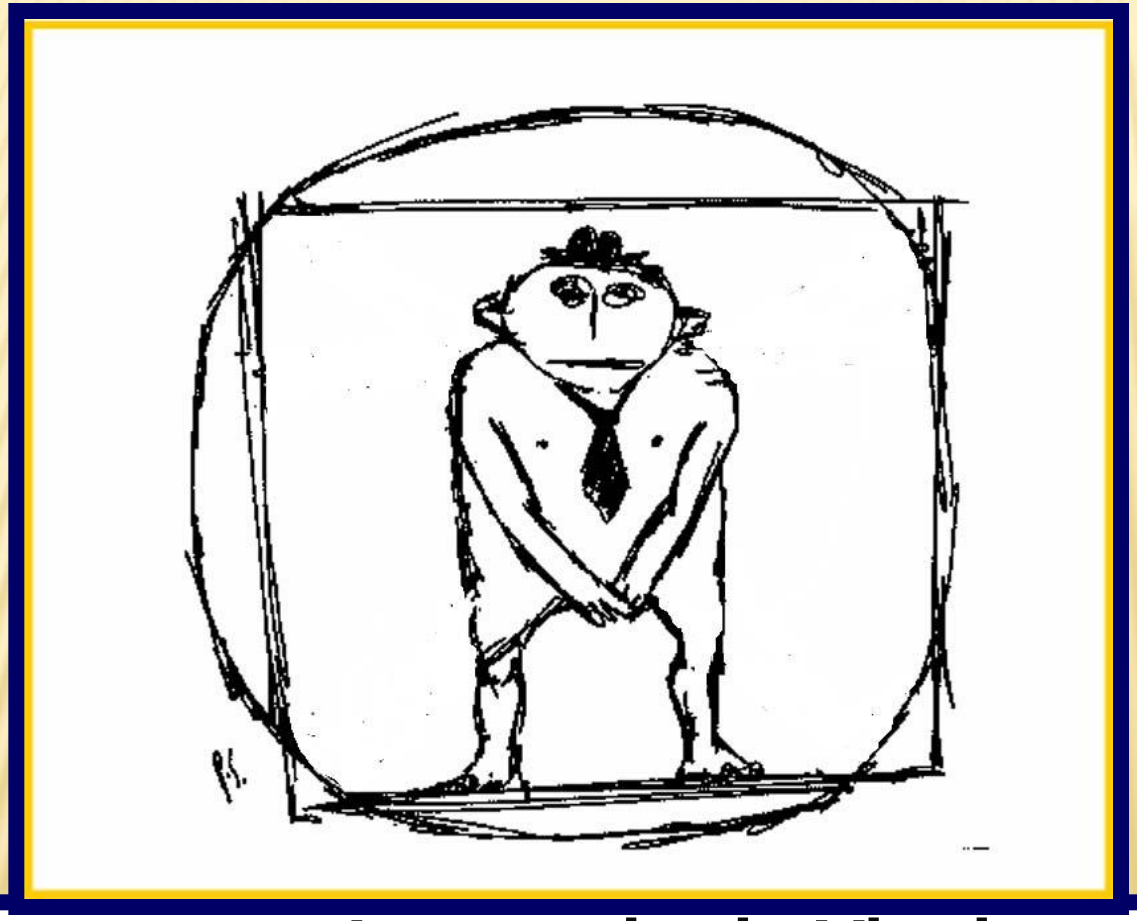


The main question: how does the visual loads affects the nutrition of the posterior part of the sclera?

Let's find out…

The rapid growth myopic patients suggests that we do not yet have a truly working and practically applicable theory of myopia.

Practical advances in the search for the root causes of the pathogenesis of myopia can be represented in the form of this funny drawing:



Virtual Man

Leonardo da Vinci.

Search for the "golden section" in the pathogenesis of myopia

about 1490-2018

The key principles in the work of the eye

- Uveoscleral outflow pathway (USOP) of aqueous humor is the only way of outflow in animals, which is closed when there is intense work at close distance.
- To provide opportunities of work at close distance in the course of evolution, humans and other 4 species of advanced monkeys have formed a second additional outflow pathway – trabecular.
- Trabecular outflow pathway (TOP) of aqueous humor is only open when the ciliary muscle tone is above average.
- This additional outflow pathway allows long-term work at close distance when USOP is closed or not effective.
- USOP - the main outflow pathway in the eye for medium and

The key principles of the work of the eye

- As we already know, the ciliary muscle is a "servant of the three Lords»: accommodation, production and outflow of aqueous humor . Each of these systems should be ranked in order of importance for the species survival.
- The main physiological principle of functional interactions of intraocular systems was first found in 1994 by researchers Ivan Koshits and Olga Svetlova (Russia).
- The principle is: the accommodation system has the absolute priority in the eye over outflow systems.
- This is a key principle of the eyes work: the to accommodate will always be a matter of priority, because it directly affects the survival of the species.
- Even in developed stages of myopia the ciliary muscle (CM) can use all its functional volume of accommodation.
- And we can support this functional ability of ciliary muscle due to

The last three basic theories of myopia

1. **The Genetics-physiological three-componented myopia theory** by E.S. Avetisov (1999): **Heredity + weakness of accommodation + near vision + weakened sclera + IOP = increase the optical axis of the eye. *This theory is an important stage in the development of an adequate theory of myopia.***

2. **The genetic theory of retinal defocus changes** by G.K. Hung and K.J. Ciuffreda (2004). **It is based on the idea of a possible acceleration of the processes of genetic eye growth even in adulthood. The most widespread theory of peripheral defocus is known for its shortcomings and is based on a number of hypotheses that are not fully supported by scientific research.**

3. **Physiological metabolic theory adaptive myopia** by I.N. Koshits and O.V. Svetlova (2001). **Acquired myopia in this theory is represented not as a disease but as a natural adaptive process which helps to reduce the energy consumption of the eye in animals and in humans during prolonged intensive work at close distance. This theory allowed to explain the results of clinical observations, provided the theoretical basis for prevention , correction and pharmacotherapy. Only a high degree of myopia and myopia with complications are considered as a disease.**

Executive mechanisms in the metabolic theory

- Initially the child's eye has a weak hyperopia refraction. This leads to the tension of the ciliary muscle during prolonged work at near distances.
- In these moments the outflow of aqueous humor through the USOP deteriorates or overlaps (O. Stachs et al.,2002,2003). The delivery of the ingredients is temporarily suspended to the middle and posterior parts of the sclera.
- Reproduction of collagen in the middle and posterior parts of the sclera in these moments is getting worse,the frame made from collagen fibers is weakened, this leads to a response in increased axis of the eye due to the actions of the IOP (I.N. Koshits, O.V. Svetlova, 2001.2006).
- The image of the object in the eye is located in front of the retina due to increase in axial length. This reduces the load on the ciliary muscle and lowers the power consumption in the eye when working at near.
- The eye has adapted to comfortable work at close distance.
- The Executive mechanism that creates a temporary functional insufficiency of the USOP is common in humans and animals.

The advantages of rational correction

1. Rational correction is a physiological possibility to “turn off” natural adaptation mechanism of optical axis growth in the eye due to retention of the ciliary muscle in the average tone using optical means.
2. This is an opportunity to make full use of the functional range of the work of the ciliary muscle.
3. It is possible to apply gentle optical correction due to full use of the physiological capabilities of the retina, that should be taken into account because of an individual visual acuity.
4. This is an opportunity to provide qualified metabolism in middle and posterior parts of the eyes due to activation of the USOP.
5. This is an opportunity to ensure prevention of opportunistic diseases with the help of optical correction which enables a natural outflow of aqueous humor.

Our new concept in optometry

- **Rational correction** is a portable optical correction of human visual system that does not affect the metabolism of the eye and allows you to use the full functional volume of accommodation in a binocular work.

- **Comfortable conditions of visual work** are such individual physiological conditions, when visual work can be carried out without stress for a long time, and when this physiological prerequisites for the development of myopia in the eye will be dissabled.

Our goals of researches with the period of 3, 5, 7 years

1. To confirm the adaptive origin of acquired myopia based on the results of comparative studies on the effectiveness of late or early optical correction.
2. To reaffirm the need for mandatory accounting of individual visual acuity of the patients to help stop the acquired myopia.
3. To conduct an in-depth study on the comparative effectiveness of application of the basic traditional and modern means of optical correction in the light of the metabolic theory of adaptive myopia by I.N. Koshits and O.V. Svetlova.

Research objectives.

1.To develop principles of stabilization of acquired myopia using early rational optical correction, allowing to slow down functioning of the adaptation executive mechanisms of the axial growth of the eye.

2. To investigate the effectiveness of stabilization of acquired myopia with the way of early rational correction using modern glasses and contact lenses compared to late insufficient traditional correction for distant vision.

3. To identify the ability of early rational optical correction to use whole functional volume of the accommodation, to easen the long work of the muscle ciliary in the extreme phases of accommodation.

4. To develop a practical recommendations for the use of early rational correction of acquired myopia with the help of the modern glasses and contact lenses. With the consideration of individual visual acuity to restore the normal levels of accommodative response and normalization of muscular balance.

Objectives of the study were the following

1. To compare the effectiveness of the traditional method of incomplete optical correction with the rational optical correction method when using glasses or contact lenses of modern design.
2. To show the benefits of choosing less strong rational correction when the individual Visual acuity is more than 20/20.
3. To show the advantages of early AM correction using MTAM hypothesis that adaptive myopia is not a disease, but a normal adaptive reaction to visual conditions in humans and animals.
4. To justify the physiological principles of prevention of AM using the rational optical correction method and give practical advices to doctors and optometrists.

Materials and methods:

1. Clinical studies involving 3546 patients with all degrees of myopia aged 7 to 37 years.
2. Duration of observation in comparable groups amounted to 3, 5 and 7 years.
3. Applied two ways optical correction of myopia: traditional incomplete correction (IC) for distance and near sight and early rational correction (ERC).
4. ERC has two main goals:to utilize the full functional range of the ciliary muscle (CM) and choose a CM tone, which interrupts or doesn't reduce the uveoscleral outflow pathway of intraocular liquid (USPO).
5. ERC provides such optical correction, which excludes the ciliary muscle work under maximum or minimum tone.

Material and methods:

6. Therefore, for far distances ERC uses a portable location focus behind the macula to a (+) 0.12-0.25 D.

7. For patients with low visual work focus at near distance the objects image is should be processed right in the macula (0.0 D), and for patients, performing a stressful and lengthy visual work at close distance - before the macula (-) 0.5 - 0.75 D.

8. Those patients who used orthokeratological lenses (OK-lens) focus is always placed behind the macula - at the value of (+) 0.25-0,5 D in the morning with a gradual change of focus location in front of the retina to a value (-) 0.25 - 0.5 D in the evening.

Optical correction tools:

1. Monofocal glasses (comparison group with correction to VA = 0.8-1.0, without determining the individual acuity),

1. Bifocal glasses with stage+ 2.0 d (comparison group with correction to VA = 0.8-1.0, without determining the individual acuity),

3. *Monofocal glasses of modern design* with a distance vision: emmetropia or weak hyperopia + 0.12 - 0.25 D,
with a close: undercorrection of - 0.5 ... 0.75 D,

4. Orthokeratology lens with distance correction of + 0,25 D, and near correction – 0,5 D,

5. *Monofocal soft contact lenses*, providing with a distance vision: emmetropia or weak hyperopia + 0.12 - 0.25 D, with glasses that provide the same undercorrection of -0.5 - 0.75 D when working near.

Progression of acquired myopia in both age groups depending on the source of Visual acuity in patients and means of optical correction during the observation period 5 years

Age, years	The average height of the refraction static eye patients in year observation period 5 years		The control group		Early rational correction			
			Glasses of traditional designs		Glasses of modern design		Lenses of modern design	
			With monofocal (MF) or bifocal Optics (BF)		With progressive Optics (PO) or with special optics design (SD) (AFP-antifatic points; NPA-nulux points active)		Soft contact lenses (SL) in combination with prophylactic glasses (PG) and OK-lenses	
			MF	BF	PO	AFP, NPA	SL + PG	OK-lenses
7- 9	Individual Visual acuity (IVA) and total increase myopia in year, dptr.	0,8	1,08	1,13	-			
		1,0	0,64	0,75	0,50	0,29	0,24	0,12
		1,25 - 1,5	-		0,26	0,18	0,15	0,06
10 -12		0,8	1,12	1,17	-			
		1,0	0,78	0,82	0,54	0,34	0,26	0,14
		1,25 - 1,5	-		0,21	0,19	0,14	0,08
13- 20		0,8	1,02	0,79	-			
		1,0	0,72	0,64	0,48	0,28	0,18	0,10
		1,25 - 1,5	-		0,17	0,14	0,11	0,06
7 - 20		0,8	1,07	0,82	-			
		1,0	0,68	0,71	0,50	0,30	0,23	0,12
		1,25 - 1,5	-		0,21	0,17	0,13	0,07
P < 0,01								

Results.

1. It has been established that the use of early rational optical correction can be more efficient method of stopping, stabilizing and preventing the progression of AM compared to late optical correction. Clinically confirmed usefulness and effectiveness of early optical correction of adaptive myopia ($p < 0.01$).

2. In patients with myopia has been proven that the effectiveness of the method of incomplete minimum correction for near (-) 0.5 - 0.75 D and complete minimum optical correction for distance (+) 0.12 - 0.25 D compared to the widespread view does not complete correction of myopia for near and far sight ($p < 0.001$).

Results.

3. Individual visual acuity as a physiological parameter describing the capabilities of a retina has a significant impact on the progression of the AM: the higher the visual acuity, the greater the stopping effect. Clinically proven need for reliable detection and documentation of individual visual acuity to assign more comfortable ERC ($p < 0.01$).

4.Researches with observation time of 3, 5 and 7 years confirmed in practice, the maximum efficiency of OK-lenses use for inhibition of AM compared to other modern non-surgical methods of optical correction ($p < 0.001$). This apparently happens because OK-lenses provide the minimum permanent focal inference for macula by (+) 0.12 - 0.25 D in the morning and refraction change throughout the day with objects image location change to the front of the retina by (-) 0.12 - 0.25 - 0.5 D in the evening.

Practical advice:

1. Optical correction should be early, begin with 0.5 diopters at any age.
2. Optical correction should be as follows:

For far distances :

- Weak overcorrection on the + (0,12…0,25) D for patients with exophoria,
- Complete correction with orthophoria and with individual visual acuity of 0,8 – 1,0.
- With individual visual acuity of 1.25 – 1.5 display focus on the retina.

For near distance:

- If exaphoria weak - overcorrection.
- With orthophoria and with individual acuity of 0.8 – 1.0 prevention glasses +0,5-0,75Д.
- With individual acuity 1,25 – 1,5 display focus on the retina.
- In esophoria use progressive lenses with +0,75-1,25 D or soft contact lenses with prophylactic prescription glasses for near work + 0,75 -1,25

Conclusion:

1.The minimum focal location for macula allows you to exclude functional insufficiency USOP. This ensures the normal delivery of metabolites for the reproduction of collagen in the middle and posterior parts of the sclera, even with intense prolonged visual work.

2.Traditional incomplete correction for far and near distances clinically did not confirm its stopping effect of AM compared to the ERC, which excludes the work of ciliary muscle at maximum or minimum tone and allows you to use the full functional volume of accommodation. Identified how effective prevention and inhibition of AM due to activation of the USOP using ERC.

3.Hypothesis of the Koshits-Svetlova metabolic theory of adaptive myopia was for the first time reliably confirmed in practice. Research of the early rational optical correction have revealed the possibility of effective prevention of AM using OK-lenses and contact lenses of modern design.

Thank You for Your attention!

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