Modified device for investigation of absolute accommodation volume. Irregular accommodation

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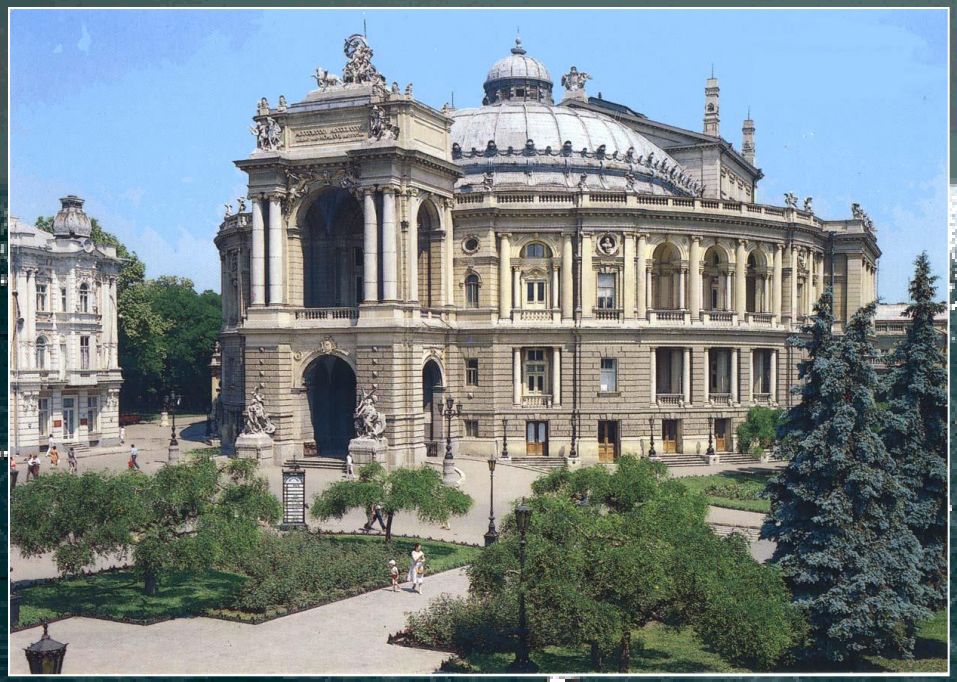


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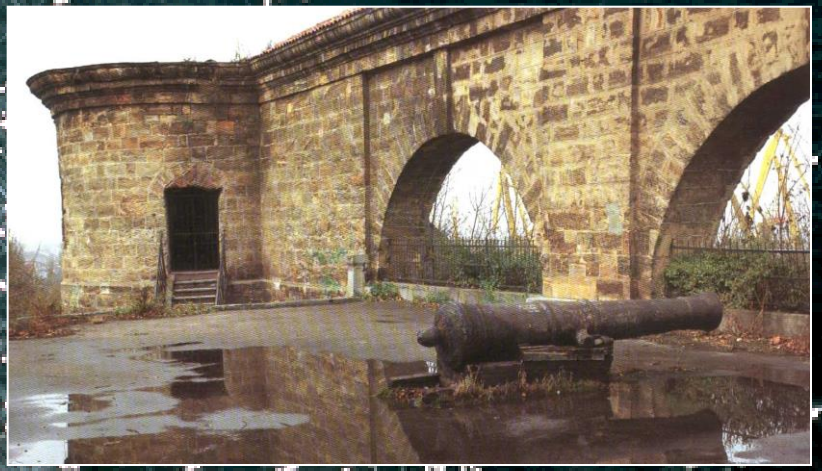


Background

- From the practice of ophthalmology it is known that if a patient with abnormalities of refraction and, in particular, with astigmatism exhibits normal not corrected visual acuity for distance and nearness, the correct position of the eyes and binocular vision is noted, asthenopic complaints and chronic inflammatory process of the eyelids and conjunctiva is absent, he can be considered fully adapted to abnormality of refraction.

Background

The adaptation to astigmatism is provided mainly by two mechanisms:

1) **irregular accommodation in different meridians;**
2) **constant fluctuations of the optical position of the eye, thanks to which either the anterior or posterior focal lines are connected with the retina (ES Avetisov, YuZ Rosenblum, 1981).**

Background

The violation of adaptation to astigmatism can be defined as follows:

- **monocular disadaptation - by the study of uncorrected and corrected visual acuity for distance and near (including meridional);**
- **binocular disadaptation –**
  1) **by determining the difference between the visual acuity of the right and left eyes (both corrected and uncorrected);**
  2) **checking the state of binocular vision;**
  3) **determining the presence of asthenopic complaints;**
  4) **diagnosis of chronic inflammation in the eyelids and anterior segment of the eye (chronic blepharoconjunctivitis).**

Background

- However, all these methods do not take into account the measurement of asymmetric meridional accommodation, which can play both a positive role (for example, compensating for astigmatism) and negative (can create the appearance of astigmatism if it is not really there, or increase its degree).

Background

As to the possibility of irregulary (asymmetric) accommodation, in the 19th century A. Nagel and VI Dobrovolsky pointed out.

Its presence can be determined by the difference between static and dynamic refraction.

However, this method is based only on determining the tone of the ciliary muscle and does not allow obtaining data on the state of its accommodative capacity.

Background

A number of researchers have been used to treat accommodation disorders in children with astigmatism the training of accommodative function.

(Adigezalova-Polchaeva K.A., Zeinalov V. Z., 1979; Shih et al., 1995; Sterner et al., 2001; Aznaurian I.E. et al., 2005; Shakarian A.A., 2005).

At the same time, when appointing treatment, authors did not take into account the state of meridional accommodation.

The relationship between the state of visual acuity and the peculiarities of meridional accommodation in children with astigmatism requires in depth study.

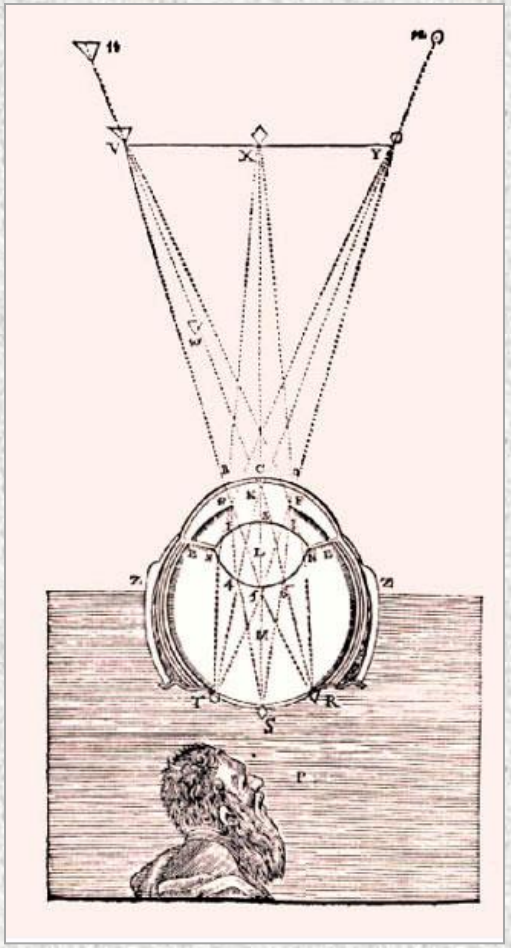
Aim of investigation

- **Increase the accuracy of the study of the volume of absolute accommodation;**
- **Investigate the relationship of meridional accommodation with uncorrected visual acuity in children with with-the-rule astigmatism in children;**
- **Propose a way to determine the nature and extent of adaptation to astigmatism.**

Material

- 123 healthy children,
- 326 children with anomalies of refraction

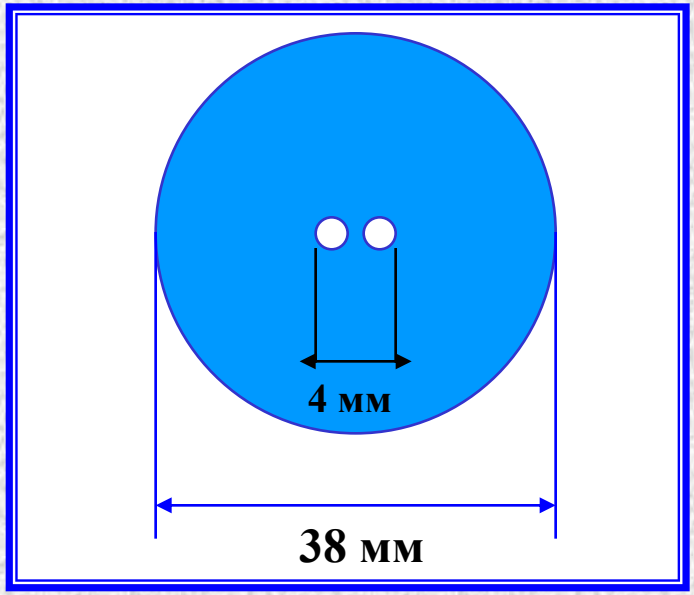
Methods



- Determination of the position of the eyes and their motility
- Investigation of the nature of binocular vision
- Definition of nearest point of clear vision in different meridians of the eye
- Biomicroscopy, ophthalmoscopy, refractometry (after 3-day atropinization)

Methods

In historic aspect it is necessary to note that for investigation of the nearest point of clear vision Scheiner (1619) proposed a special diaphragm based on the principle of provoking of monocular diplopy



Diaphragm of Scheiner

Defects:

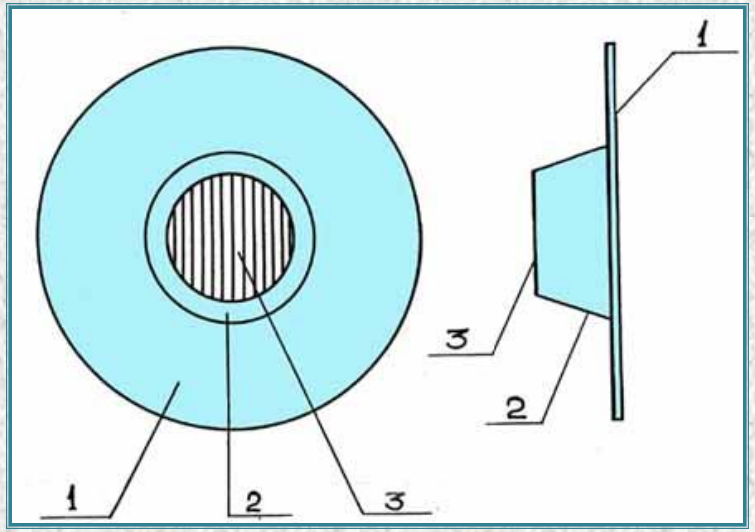
- **Reduced illumination of the pupil**
- **Narrow field of view**
- **Difficulty with centering of the diaphragm**

Methods

We proposed a modified device that makes it possible to increase the accuracy of determining the volume of absolute accommodation of the eye and to investigate it in different meridians.
(Viazovskii I.A., Serdiuchenko V. I.)

Lattice diaphragm

Theoretical background and benefits



1 - the plane of the diaphragm
2 - bottom
3 - grating

The pupil of the eye can be easily seen through the grating, which allows it to be properly centered

In the case of lattice displacement, its function does not disappear, since in any case two or three slits are projected onto the pupil

Illuminance of the retina is 5 times higher than with the use of the diaphragm of Scheiner

The field of view is expanded to 80-90 degrees

Peculiarities of investigation of the nearest point of clear vision (NPCV)

The measurement of the NPCV was carried out by approaching and removing the test object, while the researcher was to determine first the moment of bifurcation of the line, and then – the merging of the two lines into one; the average of the two measurements corresponds to the position of the NPCV.

- Initially, the grating was installed in one of the main meridians - for example, 90 ° (the position of the NPCV in the 180 ° meridian was determined - $NPCV^1$). Then the grid was installed in another main meridian – in this case 180 ° (the state of accommodation in the 90 ° meridian was determined - $NPCV^2$) and the same measurements were made.
- The obtained values of NPCV in centimeters were converted to dioptric magnitudes.
- The difference in dioptric values in the main meridians was determined:

$$\Delta NPCV = NPCV^2 - NPCV^1.$$

The study of refraction and the definition of adaptation to astigmatism

- Using an autorefractokeratometer, the degree of corneal astigmatism (ΔR) was determined from the difference in refraction in the main meridians: $\Delta R = R^2 - R^1$. We found that in 98% of children, astigmatism was corneal.
- Then the difference in the dioptric values of NPCV in the main meridians of the eye (ΔNPCV) was compared with the degree of astigmatism (ΔR), which allows to determine the nature of adaptation to astigmatism and its degree.

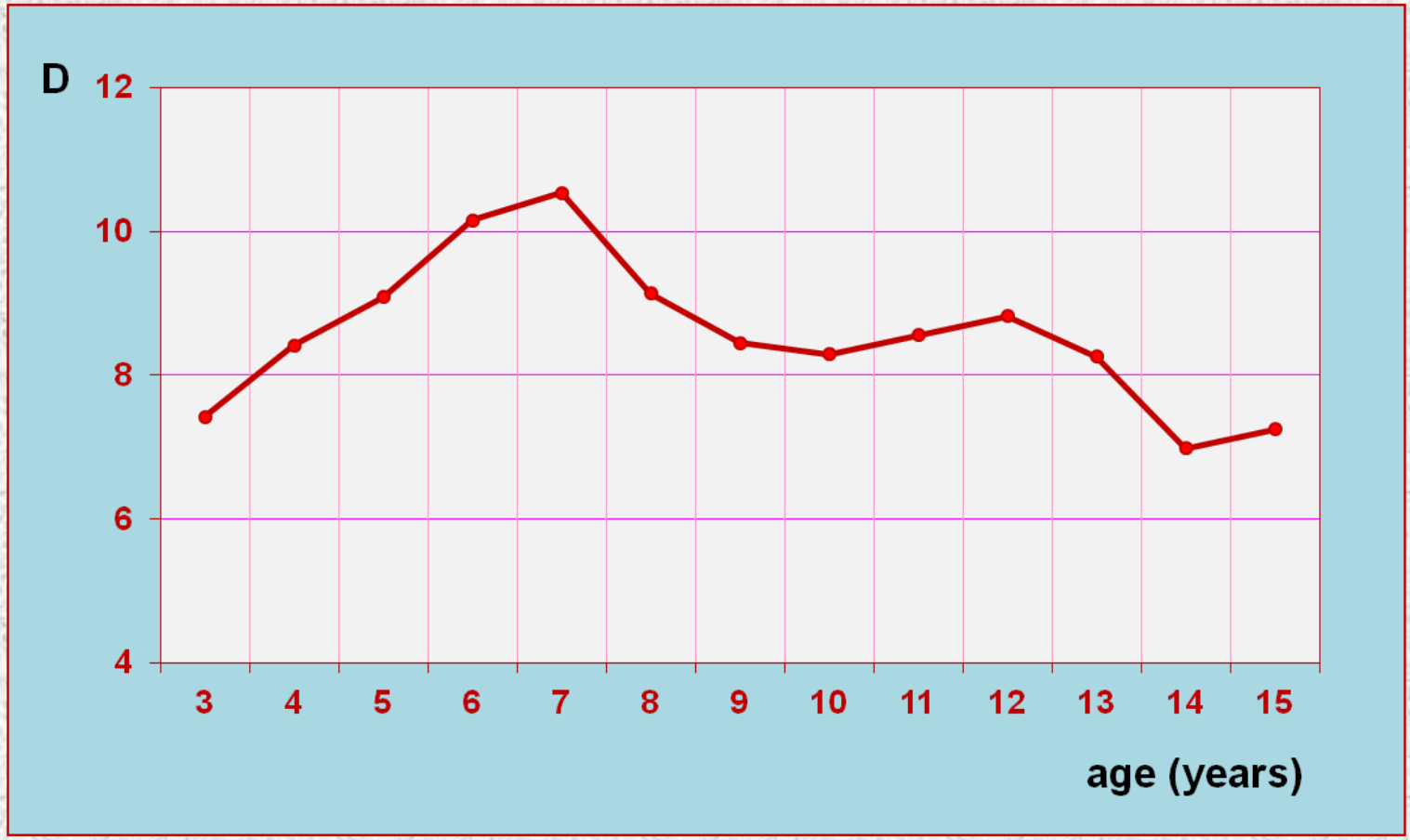
The presence of symmetrical and asymmetric accommodation at with-the-rule astigmatism is established:

- **Symmetric accommodation** – a condition in which the difference in dioptric values of NPCV in the main meridians of the eye is equal to the degree of astigmatism (ΔNPCV = ΔR). In this case, we are talking about the fact that accommodation does not affect the degree of astigmatism, or there is no "adaptation" to astigmatism.

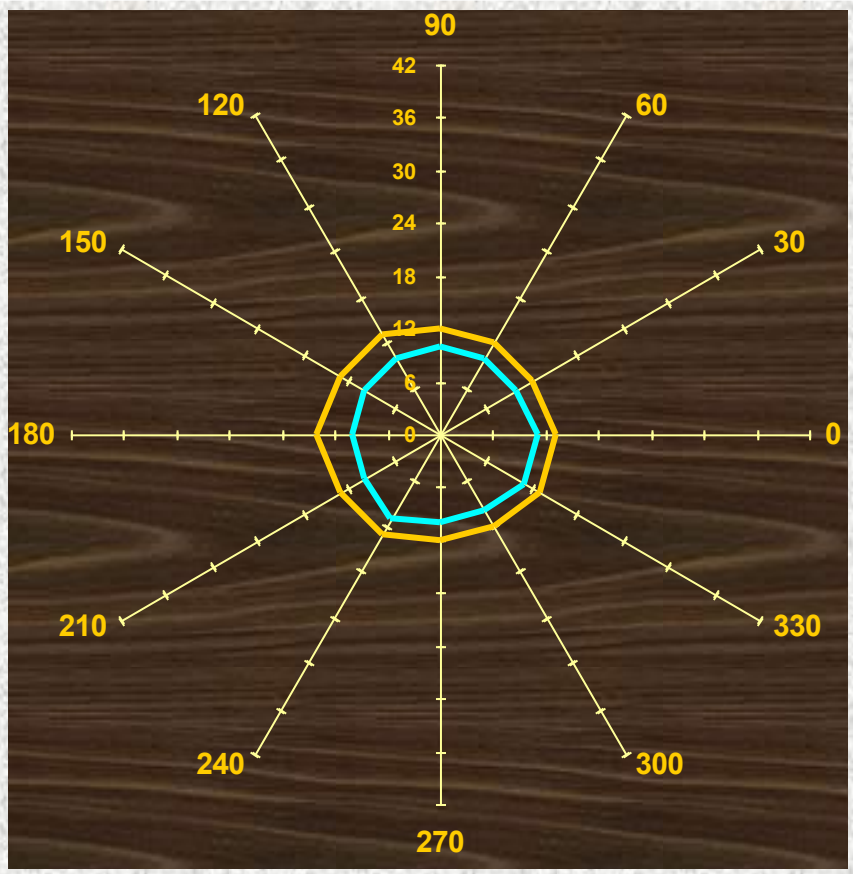
Asymmetric accommodation

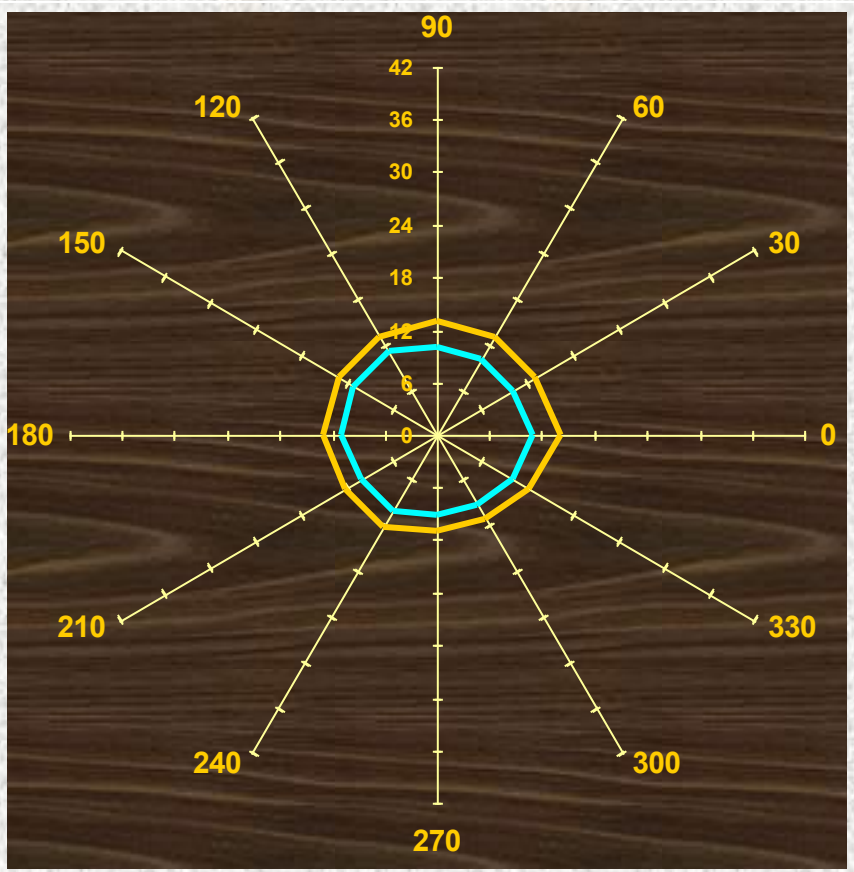
- 2a – a state where the difference in dioptric values of NPCV in the main meridians of the eye is less than the degree of astigmatism, which may indicate a partial "adaptation" to astigmatism: ΔNPCV<ΔR;
- 2 b – a state in which the difference in the dioptric values of NPCV in the main meridians of the eye is greater than the degree of astigmatism, which may indicate a "disadaptation" to astigmatism: ΔNPCV> ΔR;
- 2c – the state when the NPCV in the main meridians of the eye have the same values (complete "adaptation" to astigmatism): ΔNPCV = 0.

Absolute accommodation volume (AAV) in healthy children (D)



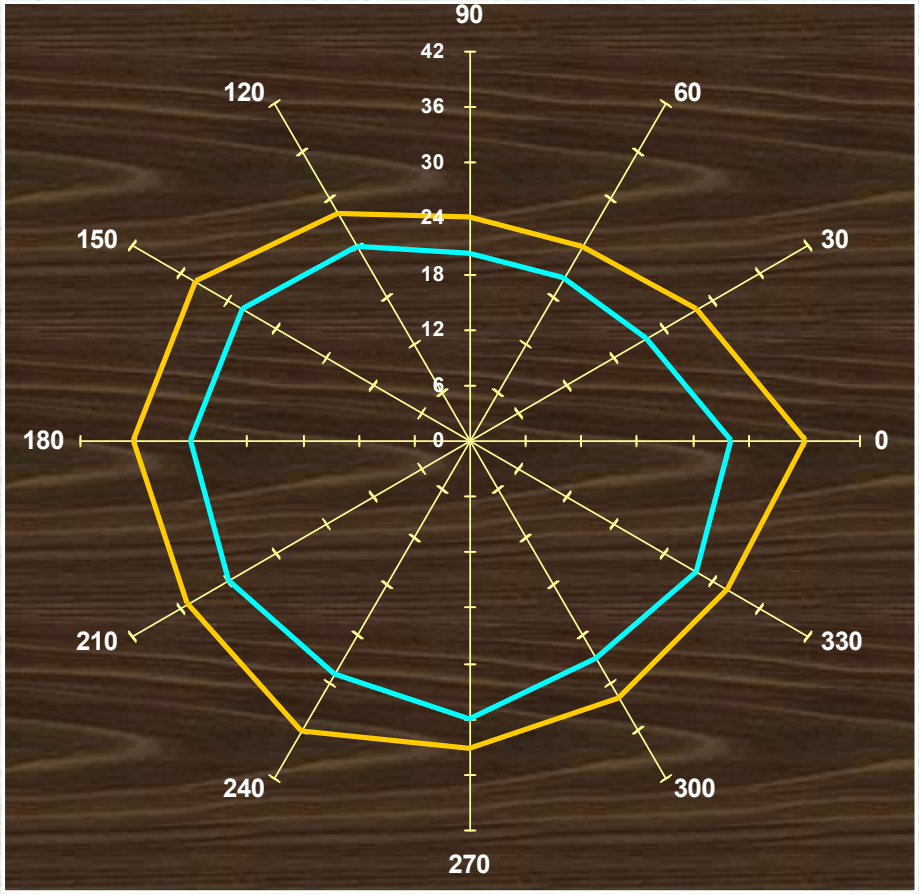
Normal accommogramme





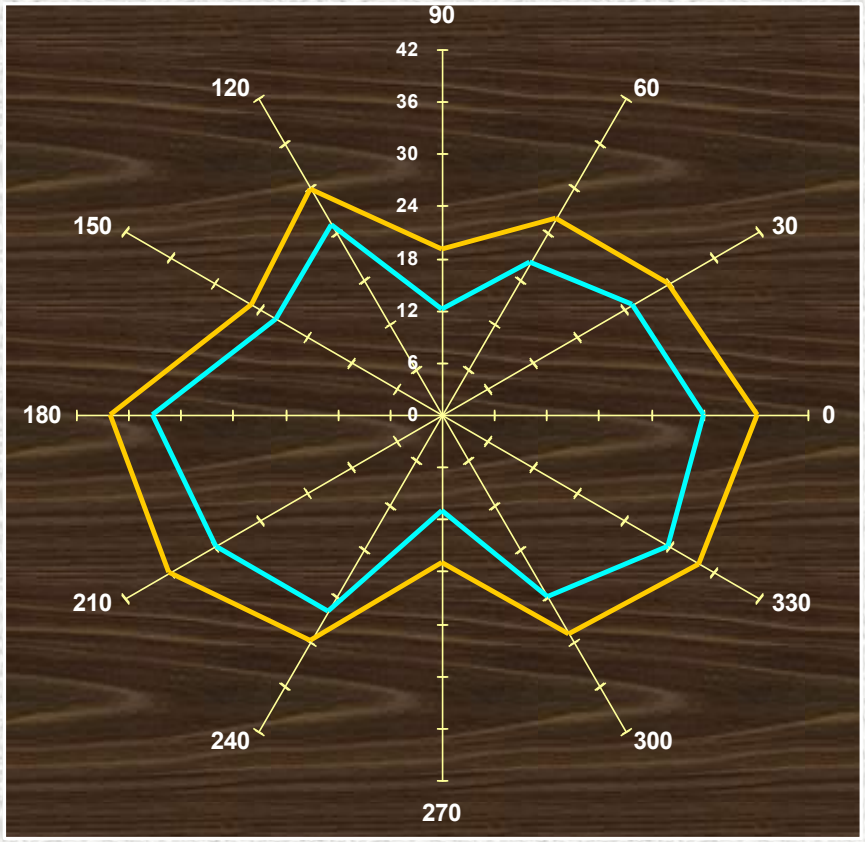
Vis OU = 1.0
R OU = Sph +0.5 D

Position of the nearest point of clear vision in hyperopia of high degree



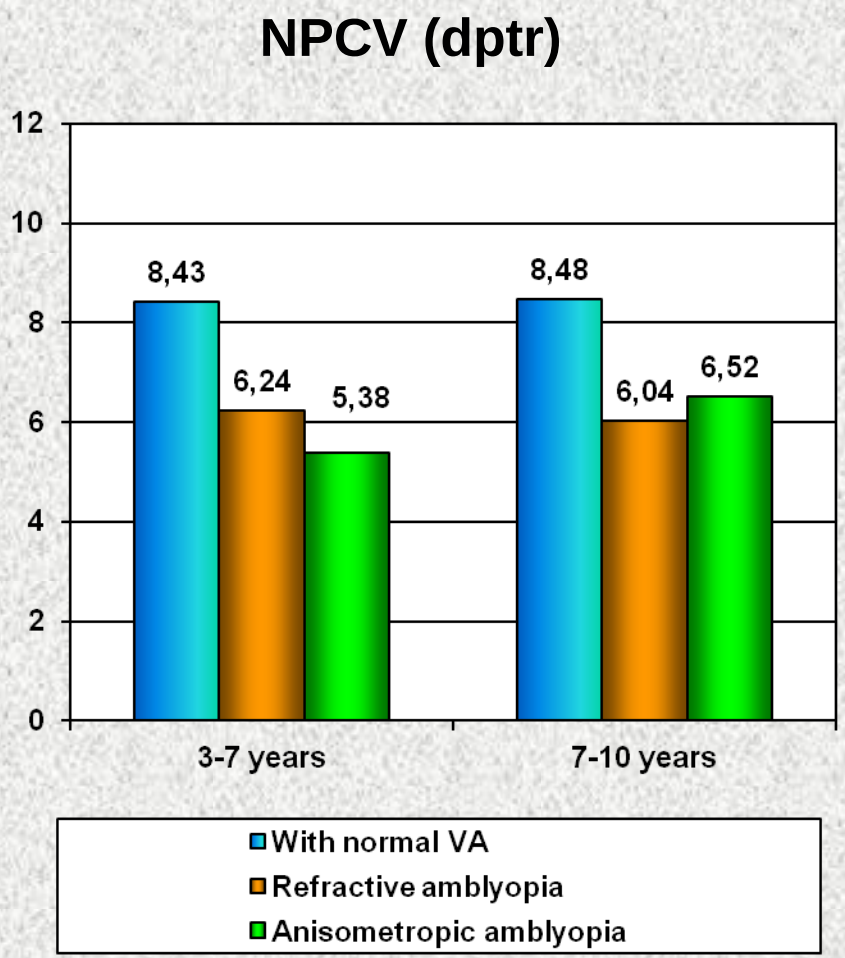
Vis OU = 0.4 Sph +6.0 D = 0.7
R OU = Hm 7.0 D

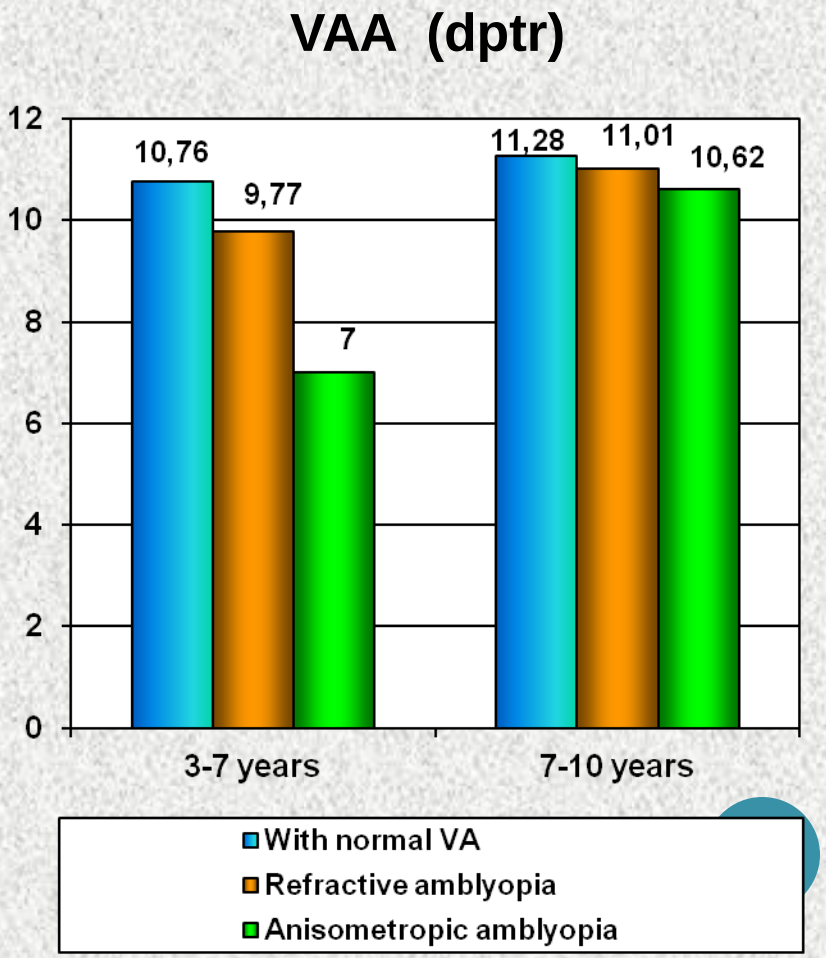
Position of the nearest point of clear vision in mixed astigmatism



Vis OU = 0.5 cc Sph -1.0, cyl +4.0 D ax 90º = 0.8
R OU = Sph – 1.5 D, cyl +4.0 D ax 90º

The nearest point of clear vision (NPCV) and the volume of absolute accommodation (VAA) in children with normal visual acuity and in children with refractive and anisometropic amblyopia on the background of hyperopia and hyperopic astigmatism

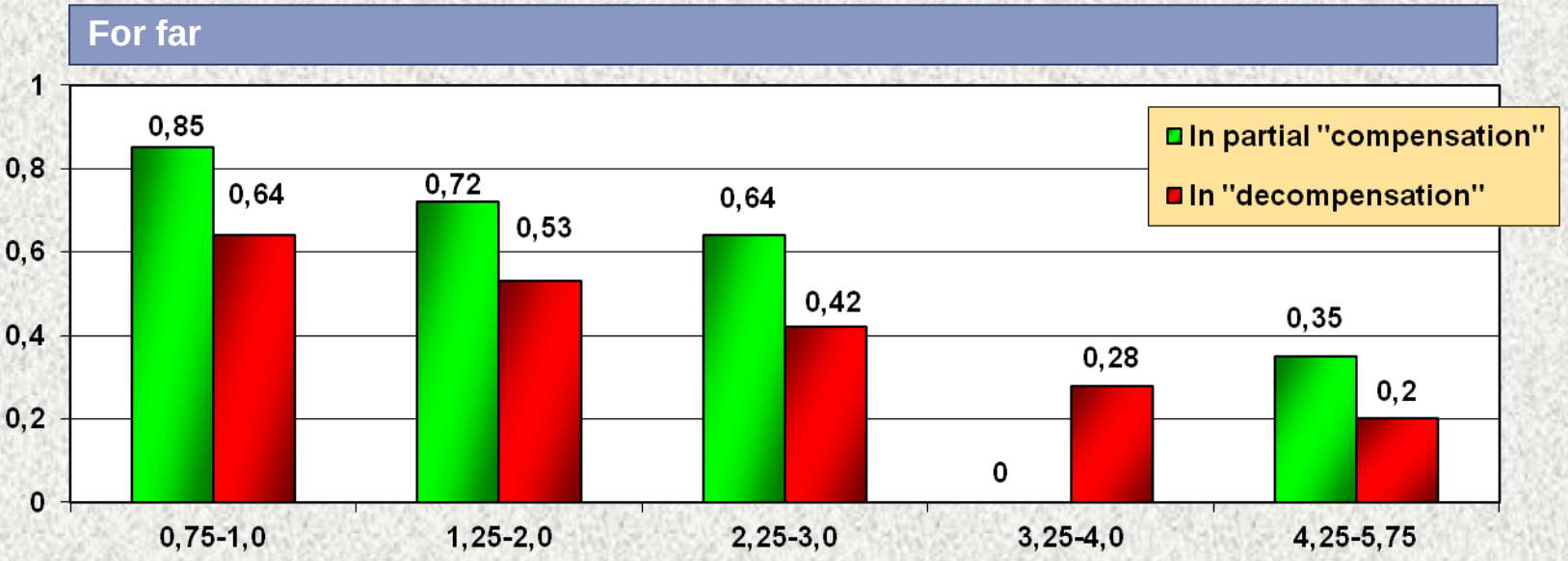


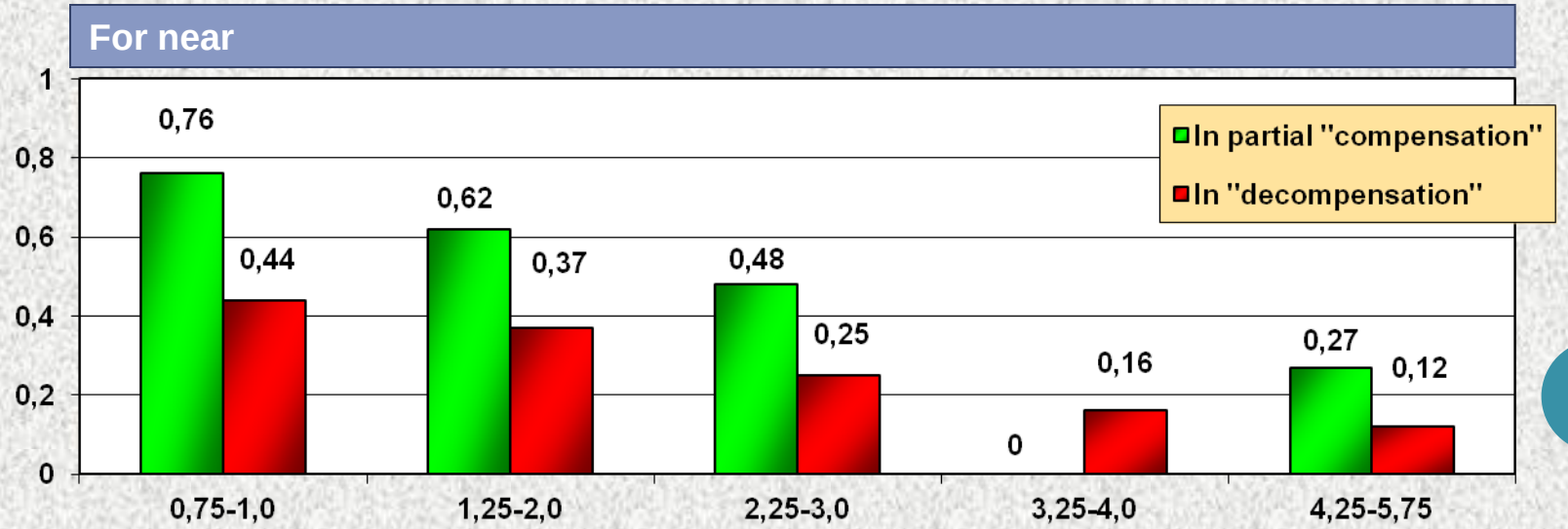


Peculiarities of accommodation in main meridians of the eye at different kinds of with-the-rule astigmatism

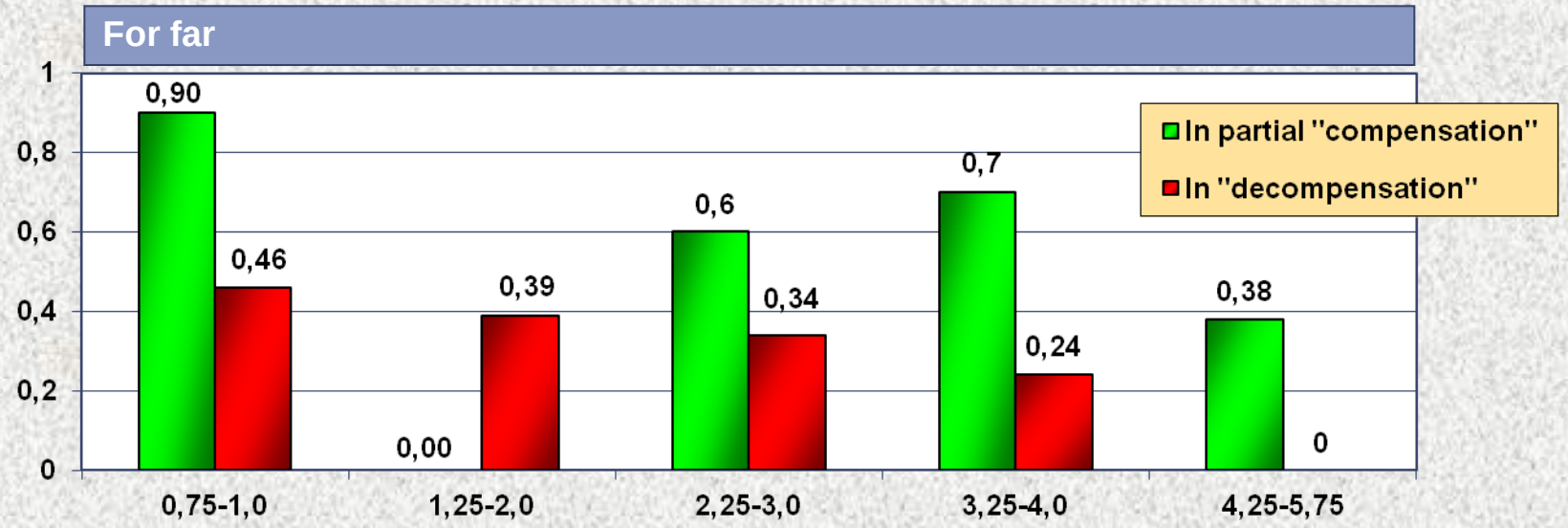
Character of accommodation	Mixed astigmatism	Hyperopic astigmatism	Myopic astigmatism
Regular accommodation	1%	4.5%	-
Partial “compensation” of astigmatism	31.6%	41.8%	23.7%
“Decompensation” of astigmatism	65.3%	52.2%	74.6%
Complete «compensation» of astigmatism	2.1%	1.5%	1.7%

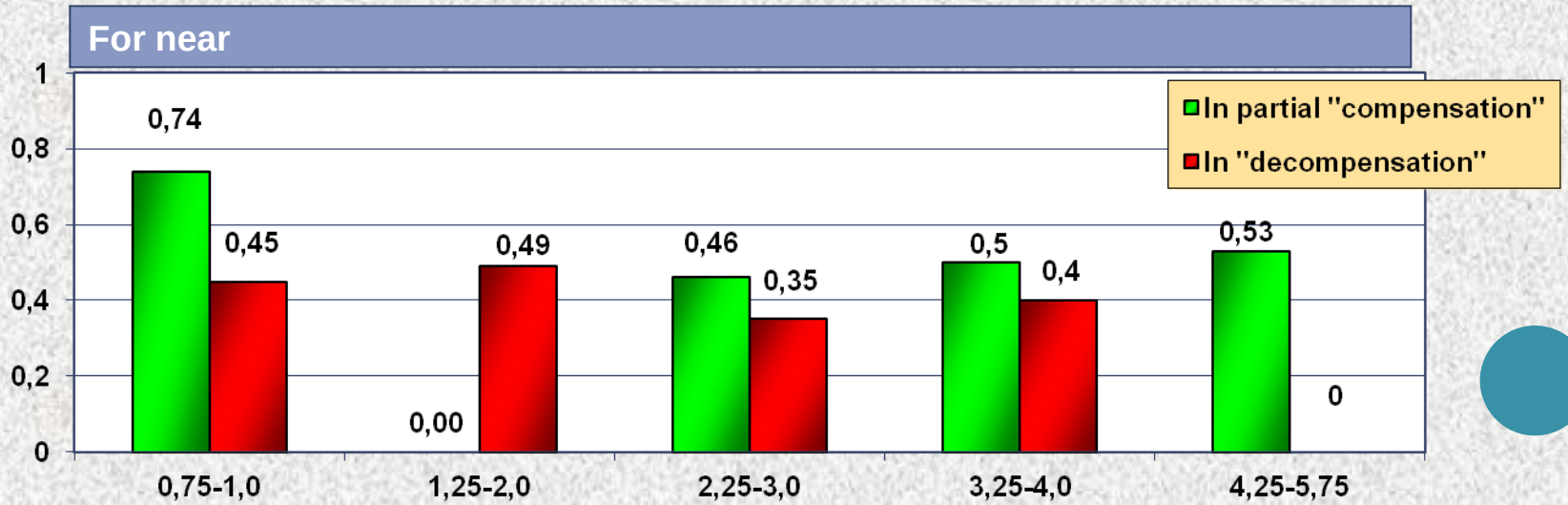
Non-corrected visual acuity in partial “compensation” and “decompensation” of hyperopic astigmatism



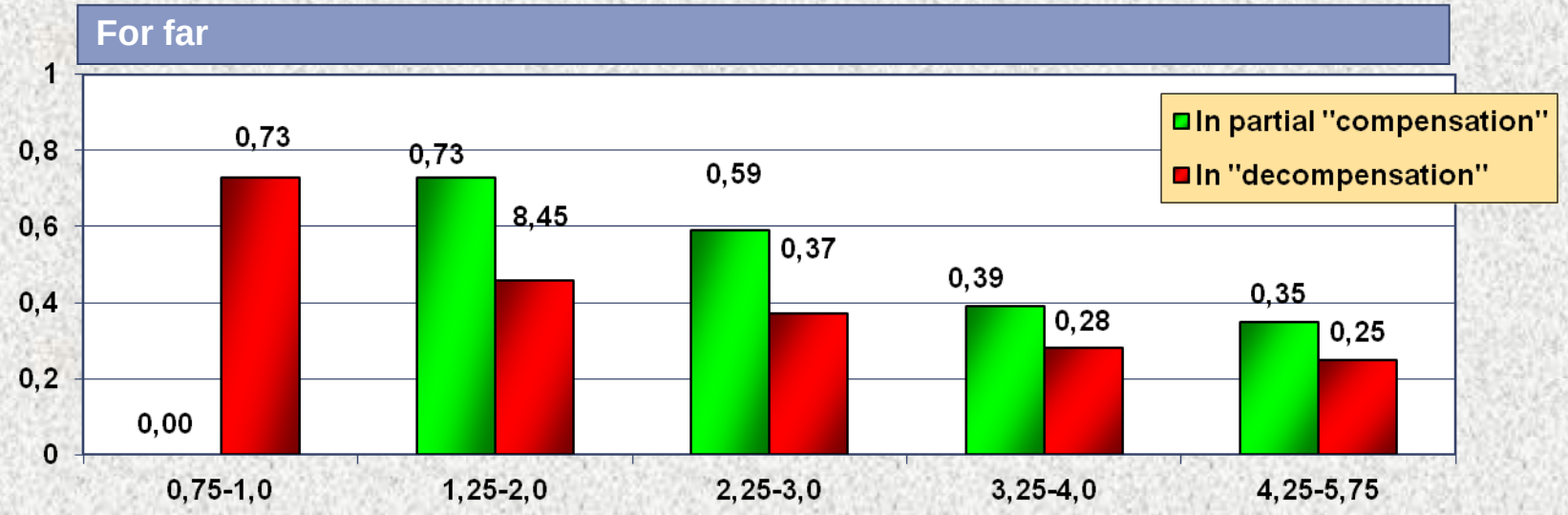


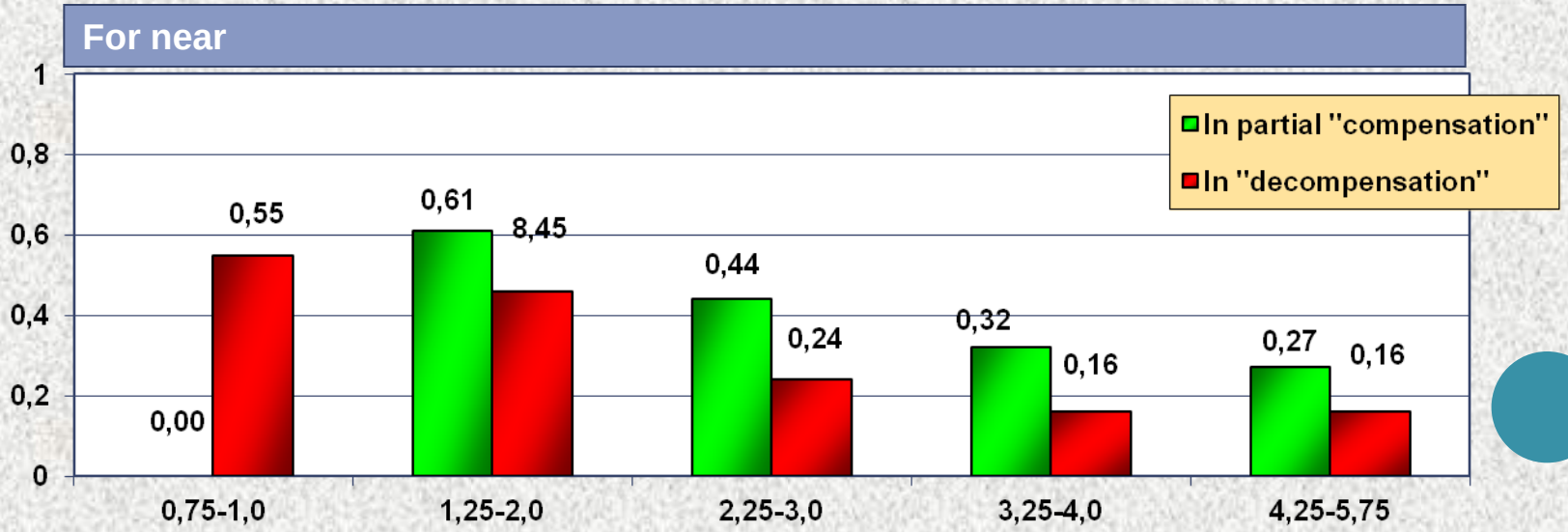
Non-corrected visual acuity in partial “compensation” and “decompensation” of myopic astigmatism





Non-corrected visual acuity in partial “compensation” and “decompensation” of mixed astigmatism





Conclusion

- The more pronounced "disadaptation" to astigmatism, the lower the uncorrected visual acuity for both the distance and the near (the inverse correlation).
- At the same time, a direct correlation was found between uncorrected visual acuity for distance and nearness and the degree of partial "adaptation" to astigmatism by asymmetric accommodation: the more pronounced the degree of adaptation, the higher the visual acuity.

Conclusion

- **Thus, our data agree with the opinion of a number of authors on the possibility in patients with astigmatism of irregulary accommodation, which may occur for self-correction of ametropia, astigmatism, and anisometropia [KA Adigesalova-Polchayeva et al., 1963, 1975]. However, under certain conditions, due to a violation of the regulatory function of the eye's adaptive apparatus, the accommodation spasm increases the degree of ametropia, astigmatism and anisometropia, which adversely affects the resolving power of the eye.**
- **All of the foregoing was the rationale for developing a method for treating accommodation disorders with astigmatism.**

Thanks for attention!