

Visual acuity and accommodation for various viewing distances in normal subjects and in patients with ophthalmopathology

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Introduction:

Recent data evidence that assessment of visual acuity and accommodation for various distances is important for individual optimization of accommodation training and functional treatment of binocular disorders.

Methods: Visual acuity and accommodation range were measured in 58 normal subjects, in 63 patients with operated concomitant strabismus accompanying by ametropia, and in 64 patients without strabismus but with ametropia. In addition, under our observation were 23 patients with artiphakia. The viewing distance was varied from 0.3 to 5 m. Visual acuity and accommodation were assessed in monocular and binocular viewing conditions. In patients with strabismus, binarimetr was used to control binocular image formation. In the cases of artiphakia and ametropia, the measurements of visual acuity were carried out under optimal optical correction for each distance.

Results: It has been found that, in the majority of the eyes with intact lens, the highest visual acuity and the best performance of accommodation correspond to the viewing distance about 1 m whereas, in patients with artiphakia, corrected visual acuity of the eyes with intraocular lens does not depend on distance. These data indicate that the peak of visual acuity at intermediate distances may be associated with lenticular mechanism of accommodation. The majority of patients with operated concomitant strabismus had very narrow accommodation range – on average, less than 1.5 D, and their binocular acuity scores were, on average, lower than corresponding monocular scores. After the sessions of functional treatment, these patients revealed a pronounced increase in binocular visual acuity coupled with a drastic widening of binocular accommodation range most clearly expressed at 1 m. The increase in monocular visual acuity was also evident but lesser than in binocular acuity. Finally, the scores of binocular visual acuity became higher than the monocular ones as was characteristic of normal vision.

Conclusion: Assessment of visual acuity and accommodation at intermediate distances, in addition to measurements at far and near, provides more comprehensive information about dynamics of treatment and visual status of patients.

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1 Introduction

In any functional correction there is obviously an aim to reach the greatest possible treatment results. However, there is no universally effective method and the effectiveness of treatment procedure may depend on the individual features of the subject and his visual system, kind of ophthalmopathy and so on. Thus, one of the most important issues in functional treatment is an accurate assessment of patient's progress that implies using the most sensitive tests. Accurate and fine assessment of current progress provides a possibility to improve a training procedure.

According to contemporary data, accommodation disorders play a significant role in different kinds of complex ophthalmopathologies [2, 4], that is why in our work we used accommodation training procedures for different groups of patients.

The aim of this work was to assess a dependency of visual acuity (VA) and accommodation range (AR) on viewing distance and to evaluate sensitivity and usability of these indices in tracing functional treatment progress.

3 Results

Visual acuity

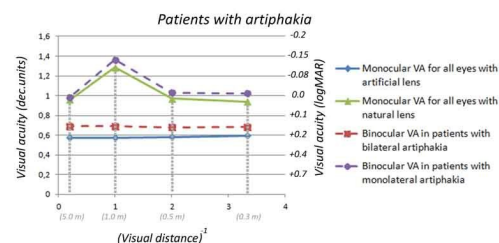
In both groups of strabismic patients (with convergent strabismus + hypermetropia and with divergent strabismus + myopia) average binocular and monocular VA before the course of functional treatment were reduced for all observation distances in comparison with ametropic group (without strabismus). Noteworthy that the binocular VA in strabismic patients was lower than monocular VA indicating impaired binocular mechanism functioning despite an orthophoric eyes axes positions (after the operation).

The data presented on the figures should be compared with the data for control group of normal patients: in this group binocular VA was on average 1.4 dec.units (-0.15 logMAR) for near distances, 1.8 dec.units (-0.26 logMAR) for intermediate and 1.6 dec.units (-0.2 logMAR) for far distance.

After the treatment, an increase of binocular VA was larger than of monocular for all patients. It was especially expressed in both strabismic groups. For all these patients, after the treatment, binocular VA became higher than monocular VA indicating normalization of interaction between binocular and monocular visual mechanisms.

Before and after treatment the highest average values of VA corresponded to the observation distance of 1 m; the positive effect of treatment was also maximal at this distance.

In patients with arthiphakia, corrected visual acuity of the eyes with artificial intraocular lens does not depend on distance. These data indicate that the peak of visual acuity at intermediate distances may be associated with lenticular mechanism of accommodation.



Accommodation range

According to the accommodation data analysis, the majority of patients with operated concomitant strabismus had very narrow AR at all observation distances before treatment – on average, less than 1.5 D. After the sessions of functional treatment, these patients revealed a drastic widening of binocular AR (to 4.0-4.5 D) coupled with a pronounced increase in binocular VA.

In ametropic patients, the binocular AR on average was 4.0 D in myopic group and 5.5 D in hypermetropic group before treatment, that is 2-3 D lower than for normal subjects. After the treatment, the binocular AR on average increased to 5.0 D in myopic group and to 7.0 D in hypermetropic group.

4 Conclusions

In patients with natural lens, average values of visual acuity, as well as improvement of visual acuity due to treatment, depended on distance and were maximal at the distance of 1 m. This means that visual acuity should be measured at different distances: not only at far and near, but also in the intermediate interval.

In strabismic patients, binocular VA was lower than monocular VA indicating impaired binocular mechanism functioning despite an orthophoric eye positions after the operation. However, after the treatment, binocular VA became higher than monocular VA.

Accommodation range for all patients with natural lens did not depend on observation distance. Accommodation training under the control of fusion provided effective interaction of binocular and monocular visual mechanisms, creating suitable conditions for VA increase, especially in strabismic patients.

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2 Methods

The subjects:

- 63 patients with operated concomitant strabismus accompanying by ametropia (31 patients with convergent strabismus + hypermetropia, 23 patients with divergent strabismus + myopia)
- 64 patients without strabismus but with ametropia (31 patients with hypermetropia, 33 patients with myopia)
- 23 patients with arthiphakia
- 58 normal subjects

Visual acuity (VA) and accommodation range (AR) were measured before and after the course of functional treatment at the viewing distances 0.3, 0.5, 1 and 5 m.

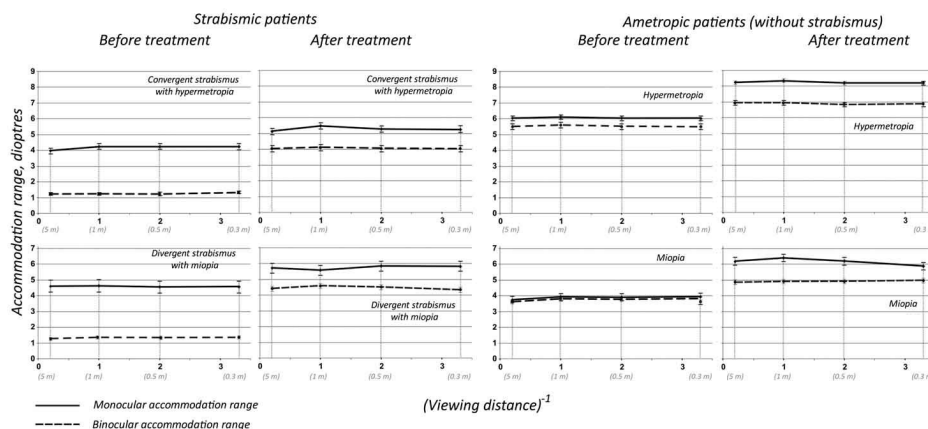
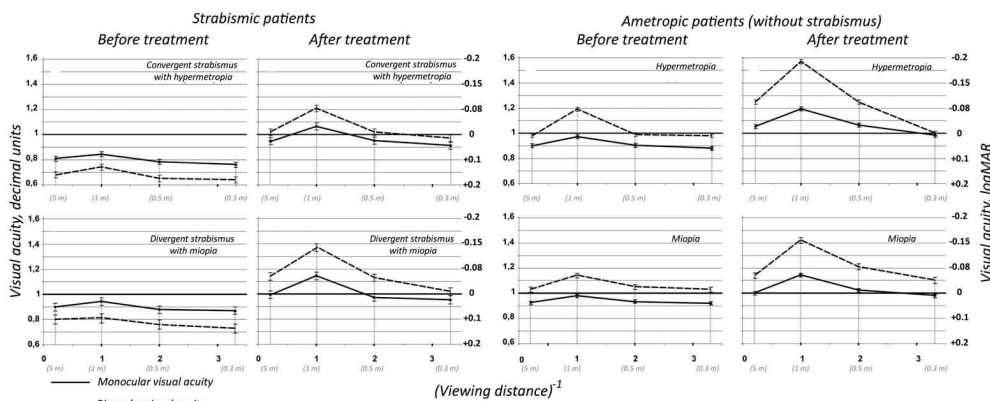
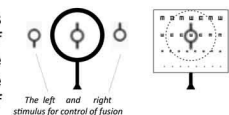
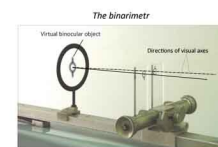
To provide accurate measuring of VA, the special test charts were used. The test charts were elaborated at the IITP RAS and contained 10 lines in the range from 0.1 (+1.0 logMAR) to 1.0 (0 logMAR) and 6 lines in the range from 1.0 (0 logMAR) to 2.0 (-0.3 logMAR) [3].

In the cases of arthiphakia and ametropia, the measurements of visual acuity were carried out under optimal optical correction for each distance.

VA and AR were assessed in monocular and binocular viewing conditions. In binocular measuring conditions, binarimetr was used to control binocular image formation (fusion) [1].

The AR was measured by means of finding maximal positive and maximal negative lenses allowing to recognize the optotypes corresponding to VA=0.7 (+0.15 logMAR).

After the initial VA and AR measuring, all patients underwent the course of functional treatment consisting of accommodation training under the fusion control. The course implied 10 sessions. The treatment was based on using the sets of positive/negative lenses for incremental loading of accommodation system.



5 References

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