DETERIORATION OF STEREOSCOPIC VISION BY ARTIFICIALLY INDUCED ANISEIKONIA

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SUMMARY

Main purpose of this study was to evaluate effect of aniseikonia on the stereo vision. We had together 90 subjects without eye pathology with or without habitual correction. Five of them were excluded due to important anisometropia or bad visual acuity (V < 0.5 on worse eye). All 85 subjects every in 4 cases (without size lens, with size lens on OD 1, 3 and 5 %) undergone measuring of their stereoscopy parallax. This was evaluated by Random dot stereo test. The level for stereoscopy vision was set bellow 60 arc seconds. This criterion was not achieved naturally by 6 subjects, so final number of all cases was 316 (100 %). As a whole 48 subjects (15.2 %) fail after using the test with size lens on OD 1, 3 or 5 %. All 268 cases (84.8 %) had not impaired stereoscopy parallax with size lens over chosen critical level.

Key words: size lens, anisometropia, aniseikonia, heterophoria, stereoscopy vision

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INTRODUCTION

In anisometropia we find different refraction between the right and left eye. The first mention of anisometropia originates from the 17th century. We differentiate between hypermetropic, myopic, mixed and astigmatic forms of anisometropia. There is also latent anisometropia. A frequent cause of anisometropia is astigmatism. A further cause may be e.g. keratoconus, unilateral microphthalmos, unilateral aphakia, inflammatory disease of the anterior segment of the eye and various degrees of cataract. We also find transient anisometropia in patients with systemic diseases. It may appear in febrile illnesses, diabetes etc. The most common type of anisometropia is myopic, which occurs in 40% of cases. Anisometropia of a size of minimum 2 D occurs in minimally 20% of patients with a refractive error. Anisometropia of a size of 2.5 D, thus a condition in which the size of the retinal images differs by 5%, is usually the limit for binocular vision. Aniseikonia is linked to anisometropia. It is a condition in which the image of an object has a different size and shape when perceived by the right and left eye. In iseikonia the images in both eyes are entirely identical. We can divide iseikonia into dynamic and static. The causes of aniseikonia are optical and non-optical. We can divide the optical causes into natural and artificially induced. The artificially induced types of aniseikonia include glasses correction aniseikonia. The main manifestation of aniseikonia is a malfunction of binocular vision.

Correction of anisometropia and of the resulting aniseikonia is an important function which can ensure correct binocular vision for the patient. The literature states that anisometropia of a size of 2 D occurs in 20% of patients with a refractive error. These patients also suffer from aniseikonia, which impairs the speed and quality of binocular vision. In the majority of patients the correct solution to aniseikonia is glasses correction with the help of enlarging lenses, contact lenses or a combination of both of the above methods.

It is also possible to treat aniseikonia with the help of refractive surgery. According to Berthke [1], the optimum value of postoperative anisometry in the case of targeted monovision is 1.5 dioptres between the 40th and 50th year. This represents a value which enables relatively good quality vision, including retaining of stereoscopic vision. With advancing age problems occur with tolerating this value of anisometropia.

At present a “hook test”, which is a component of modern projection and LCD optotypes, is used for the measurement of aniseikonia. The examination enables determination of the size and type of aniseikonia. It is also possible to use diagnostic iseikonic glasses lenses. There are also special electronic systems which work on the principle of eikonometers, which are instruments for determining the size of aniseikonia. These electronic systems enable quick, quality and precise measurement of the size of aniseikonia and proposal of the method for resolving this problem.

METHOD

The study was conducted on a total of 90 subjects without significant ocular pathology, with an average age of 25 years (minimum 19 and maximum 59 years). The examination of aniseikonia and subsequently of stereoscopic vision was performed naturally or with the subject's own habitual correction. The average refractive condition or correction rounded up to 0.25 D in the right eye was -2 D sphere (minimum -8.5 and maximum +5 D), -0.25 D (minimum -1.75 and maximum +2.25 D) cylinder in an axis of 38 degrees (minimum 0 and maximum 180 degrees). In the left eye we measured -1.5 D sphere (minimum -8.25 and maximum +4 D), -0.25 D cylinder (minimum -1.75 and maximum +2.25 D) in an axis of 50 degrees (minimum 0 and maximum 180 degrees). A total of 4 subjects, in whom we measured a size

of actual anisometropia in the spherical or cylindrical value larger than 1 D, were excluded from the study cohort. In the remaining subjects we did not demonstrate aniseikonia or pronounced heterophoria or fixation disparity using a hook polarisation test.

Also evaluated were visual acuity, natural or corrected by the subjects' own habitual correction. The average value of visual acuity in the right eye was 1.20 decimally and in the left eye 1.17 decimally. Two subjects with visual acuity in at least one eye lower than 0.5 decimally were excluded from the study, one of whom had already been excluded due to unacceptable anisometropia, so the total number of excluded subjects was 5.

The actual measurement of stereoscopic parallax took place using a Random dot stereo test. The minimum value of stereoscopic parallax measured here was 12 arc seconds and the maximum 400. All the measurements took place under identical conditions (lighting, correction or without correction, examining distance).

The examination began with the placing of an iseikonic lens (size lens) with enlargement of 5% in front of the right eye of the subject. The subject either had own correction or was without correction, in the case of good visual acuity and in the case that the subject did not use a corrective aid. The determined size of stereoscopic parallax was recorded. Subsequently we placed an iseikonic lens in front of the right eye of the subject with an enlargement value of 3%. We again recorded the determined size of stereoscopic parallax. In the next step we used a size lens with enlargement of 1%, and in the last case the patient was tested on a stereo test naturally or with own habitual correction.

The results were converted into an MS Excel table and subsequently statistically evaluated with the help of the Statistika program version 12 from the STATSOFT company.

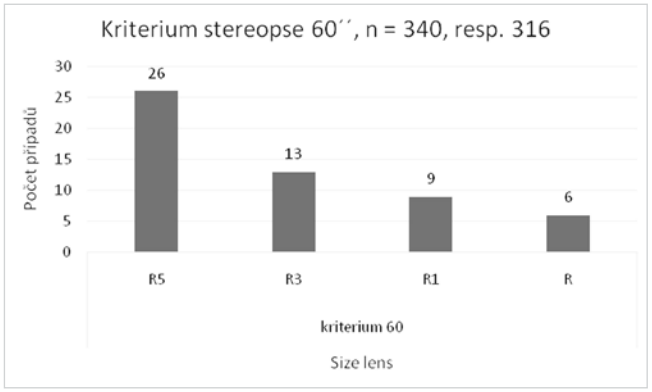
RESULTS

We divided the results of measurement into a total of 4 groups. The group designated R5 contained data on stereoscopic parallax with the use of an iseikonic lens with enlargement of 5%, the group designated R3 contained data on use of a lens with enlargement of 3%, group R1 a lens with enlargement of 1% and group R contained natural stereoscopic data. On the basis of confirmation of a zero hypothesis concerning the non-parametric distribution of data in all the examined groups (Kolmogorov-Smirnov test, groups R5, R3, R1, R all $p<0.01$), for an evaluation of statistically significant differences between the individual groups we used a Wilcoxon pair test, which in all cases confirmed the zero hypothesis concerning the statistically significant difference between the individual neighbouring groups ($p<0.001$ in all cases). This means that a statistically significant deterioration of stereoscopic vision occurred with each size lens.

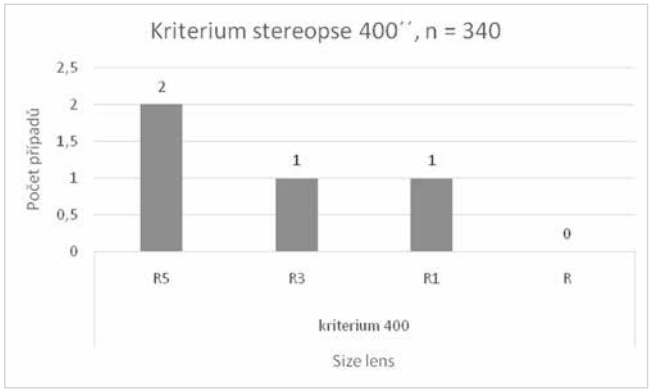
From a practical point of view, and on the basis of an evaluation of the minimum requirements for stereoscopic vision [6], we can state that impairment of stereoscopic vision occurred upon placement of size lenses of various sizes on a total of 48 subjects in the case of a stereoscopic vision limit of 60´´ (see graph 1, 6 subjects had impaired stereoscopic vision already without a size lens) and in 4 subjects in the case of a stereoscopic vision limit of 400´´ (see graph 2) out of a total number of 340 cases.

Table 1: Wilcoxon test between neighbouring groups (R5, R3, R1 and R).

Dvojice proměnných	Wilcoxonův párový test (Tabulka 1) Označené testy jsou významné na hladině p <,05000			
	Počet platných	T	Z	p-hodn.
R5 & R3	53	36,50000	6,011027	0,000000
R3 & R1	38	43,50000	4,742244	0,000002
R1 & R	27	37,50000	3,639787	0,000273



Graph 1: Number of cases of impairment of stereoscopic vision at criterion of 60´´.



Graph 2: Number of cases of impairment of stereoscopic vision at criterion of 400´´.

DISCUSSION

In the study a statistically significant difference was demonstrated between the use of individual size lenses. Each size lens (1, 3 and 5 %) deteriorated the quality of stereoscopic vision by a statistically significant value (average R = 32.28´´, R1 = 38.87´´, R3 = 43.98´´, R5 = 64.96´´, Wilcoxon test all $p<0.001$).

A fundamental problem in evaluating stereoscopic vision is the fact that there is no precise boundary for its definition. Rutrle [6] states values of 20 – 60 arc seconds. Friedmann [2] states values of 20 to 50 arc seconds. According to Howard [3] we can consider stereoscopic parallax lower than 40 arc seconds to be functional.

In our study we therefore selected as our criterion the values of 60 and 400 arc seconds. In total we had 340, or respectively 316 cases available. We can state that upon the use of the stricter criterion (60´´), 6 subjects did not reach quality stereoscopic vision even before the actual experiment (without size lens), and subsequently there was a deterioration of stereoscopic vision in 48 cases out of 316 (15.2%) after placement of a size lens. Of these, 9 cases (2.8%) were with a size lens of 1% (R1), 13 cases (4.1%) with a size lens of 3% (R3) and in 26 cases (8.2%) with a size lens of 5% (R5). In the case of the reduced criterion (400´´), the subjects did not reach quality stereoscopic vision in a total of 4 cases (1.1%), of which 1 case was in in R1, 1 case in R3 and 2 cases in R5.

The quality of stereoscopic vision may also be influenced by the size of heterophoria. According to the authors Lam and Tse [4], the best stereoscopic vision was attained by the group with orthophoria (5.31´´), followed by the group with exophoria (6.02´´) and the worst result was in the group with esophoria (8.91´´).

In our group we excluded pronounced heterophoria (fixation disparity), similarly as in the case of pronounced aniseikonia with own correction or naturally, by means of a hook test.

The objective of our study was to evaluate the influence of aniseikonia on the quality of spatial vision. We tested subjects without pronounced ocular pathology with their own correction or naturally (total of 90 individuals, of whom 5 were excluded for anisometropia, n = 340, respectively 316). We conducted testing on a Random dot polarised stereo test with the use of a size lens (5, 3 and 1 %). In the case of the stricter criterion (60´´), we determined that a total of 6 subjects had impaired stereoscopic vision already before the use of a size lens. Subsequently in 48 cases (15.2%) there was a significant impairment of spatial vision upon the use of a size lens through the inducement of aniseikonia 1, 3 or 5%.

In conclusion we can state that spatial vision upon artificially induced aniseikonia 1, 3 or 5% was not significantly impaired in a total of 268 cases (84.8 %) out of a total number of 316 cases.

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LITERATURE

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