CHANGES IN THE VISION OF ADULT AMBLYOPIC PATIENTS FOLLOWING CLEAR LENS EXTRACTION

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SUMMARY

Aims: The aim of the study was to retrospectively evaluate changes in vision after the implantation of trifocal (tIOL) or rotationally asymmetric multifocal artificial intraocular lenses (mIOL) in patients undergoing clear lens extraction. The main goal was to determine whether changes to central visual acuity occur after the implantation of an IOL at a follow-up examination after one year. Other objectives were to determine the difference between the groups with implanted diffractive and rotationally asymmetric artificial intraocular lenses, as well as to evaluate the risk of accurate correction in patients who had lived most of their lives "undercorrected".

Material and methods: In our study, we present a retrospective longitudinal evaluation of results in patients after the implantation of an artificial intraocular lens. In the period from 2013 to 2020, we evaluated changes in the vision of 22 patients aged 39–59 years, of whom 18 were women and 5 were men. The average preoperative refraction of amblyopic eyes was +5.7 ±2.13 Dsf and +1.24 ±0.86 Dcyl. In amblyopic eyes, 7 diffractive lenses and 15 rotationally asymmetric lenses were used.

Results: Uncorrected distance visual acuity before surgery and one year (1Y) after was 0.13 ±0.09 vs. 0.57 ±0.28 ($p < 0.001$); the best corrected distance visual acuity before and 1Y after was 0.53 ±0.22 vs. 0.62 ±0.29 ($p = 0.024$); uncorrected near visual acuity before and 1Y after was 0.06 ±0.06 vs. 0.48 ±0.32 ($p < 0.001$); the best corrected near visual acuity before and afér the surgical procedure was 0.45 ±0.27vs. 0.55 ±0.35 ($p = 0.014$).

Conclusion: Implantation of tIOL and mIOL lenses was effective in our group of patients with amblyopia, thus improving uncorrected distance and near visual acuity and without serious adverse effects. At the same time, we evaluate that the change in refraction and the removal of anisometropia lead to a significant change in the best corrected visual acuity for distance or near vision at the one-year follow-up examination.

Key words: amblyopia, CLE, intraocular lens

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INTRODUCTION

Amblyopia is the most widespread pathology in childhood age, also known as “lazy eye”. It is a functional pathology, defined as a “developmental defect of spatial visual processing, which occurs in the central visual pathway” [1]. Morphologically and functionally both eyes are generally in order, whereas the problem consists in the interpretation of the image in the brain, because the eye was not sufficiently stimulated during development in early childhood age. The reasons for reduced stimulation are most commonly anisometropia, deprivation of stimulus or strabismus.

The critical period, or maximum neuroplasticity limit of the visual cortex for the treatment of amblyopia, is between the 6th and 8th year of age. The gold standard in the treatment of amblyopia is penalization, directed at forcing the use of the amblyopic eye [2]. This type of treatment of amblyopia is generally effective up to the age of 7 years [3]. The greatest risk of untreated amblyopia in childhood age is trauma or pathology of the dominant eye, which is a risk factor for blindness [4]. Despite this, we know of patients in whom best corrected visual acuity (BCVA) of the amblyopic eye has improved in adult age following a trauma of the dominant eye [5].

Observations are scant as regards the effectiveness of multifocal intraocular lenses in amblyopic patients following clear lens extraction (CLE). At present there are 2 published studies dealing with amblyopia and the implantation of multifocal IOLs, in both of which the patients express subjective satisfaction. The first study observed 14 patients with amblyopia resulting from anisometropia (without strabismus, without microtropia) and implantation of a rotationally asymmetric multifocal (MPlus, Oculentis) intraocular lens [6], and the second study observed 3 anisometropic amblyopic patients with cataract (one hypermetropic, two myopic) without strabismus, and implantation of a diffractive multifocal (AcrySof ReSTOR, Alcon) intraocular lens [7].

Multifocal intraocular lenses are not routinely used in patients with amblyopia. According to some sources, implantation of a multifocal intraocular lens in the case of amblyopia is in fact contraindicated, as is the view of the Austrian authors who published a case report of a female patients following surgery for strabismus and anisometric amblyopia without central fixation following the implantation of trifocal (AT Lisa tri toric 939, Zeiss) artificial intraocular lenses [8]. Amblyopia is not a monocular condition, and is not merely a defect of reduced visual acuity, but is rather an abnormal development of the binocular visual system, affecting both eyes [9]. As a result, due to the risk of diplopia some ophthalmologists are reluctant to interfere with a defectively developed binocular system.

Today the use of multifocal intraocular lenses is the standard procedure upon clear lens extraction. The selection criteria for patients are narrow, and in our practice the unwritten rule applies that we recommend surgery to hypermetropic patients with best uncorrected distance visual acuity of less than 0.7 decimal and low uncorrected near visual acuity. Practically these are patients with a refractive error of > +1.0 Dsf and age of > 50 years. In amblyopic patients we are all the more rigorous in considering whether or not they will definitely have better vision after surgery than beforehand, but in the case of anisometropic amblyopia it is simpler to correct anisometropia with the aid of an artificial intraocular lens in comparison with glasses correction, due to the risk of aniseikonia. At the same time, we emphasize that multifocal lenses cause lower contrast sensitivity.

Aniseikonia may be a problem, especially in the case that the patient has worn full correction from a young age and the brain has become accustomed to the difference in sizes of images, precisely speaking it has "imprinted" a larger image from a larger plus diopter as correct, as described by the aforementioned Austrian authors [8]. From our clinical experience, it ensures that the widespread practice is not to use full glasses correction in adult anisometropic patients. In practice this means that the patient wears glasses correction of equal diopters, according to the dominant eye. From long-term observation this probably concerns a combination of cosmetic reasons (greater plus diopters enlarge the eye) and prognostically negative outlooks for the improvement of central visual acuity ("the patient will no longer attain full correction in adult age").

In our study we theoretically analyze the current options and retrospectively evaluate a cohort of anisometropic patients in whom a trifocal or rotationally asymmetric artificial intraocular lens was implanted during CLE.

MATERIAL AND METHOD

In our study we present a retrospective longitudinal evaluation of the results in patients following the implantation of an artificial intraocular lens. A total of 34 amblyopic patients underwent the surgical procedure CLE in a single center during the observation period of 2013–2020. The group of monofocal artificial intraocular lenses comprised 7 patients aged 43–57 years, of whom 5 were women and 2 were men. The group of multifocal/trifocal artificial intraocular lenses comprised 22 patients aged 39–59 years, of whom 17 were women and 5 men. Preoperative refraction in the amblyopic eyes was +5.7 ±2.13 Dsf and +1.24 ±0.86 Dcyl. Amblyopic patients with another ocular pathology were not included in the analysis, and as a result 4 patients were excluded from the analysis (1. s/p schwannoma operation on contralateral side, s/p keratopathy in both eyes, 2. maculopathy in both eyes, 3. glaucoma chronicum simplex in both eyes, 4. Fuchs' corneal dystrophy in both eyes.)

All the patients were classified as anisometropic amblyopia. In the group of multifocal lenses, 15 eyes (of which 3 men, average age 49.5 ±6.4 years) were evaluated in patients with anisometropic amblyopia without a medical history of strabismus or previous strabismus surgery, and 7 eyes (2 men, average age 48.3 ±6.4 years) were evaluated in patients with a positive medical history of previous strabismus surgery (7 patients).

Altogether 22 implanted multifocal IOLs were analyzed. The mean value of all the implanted lenses was

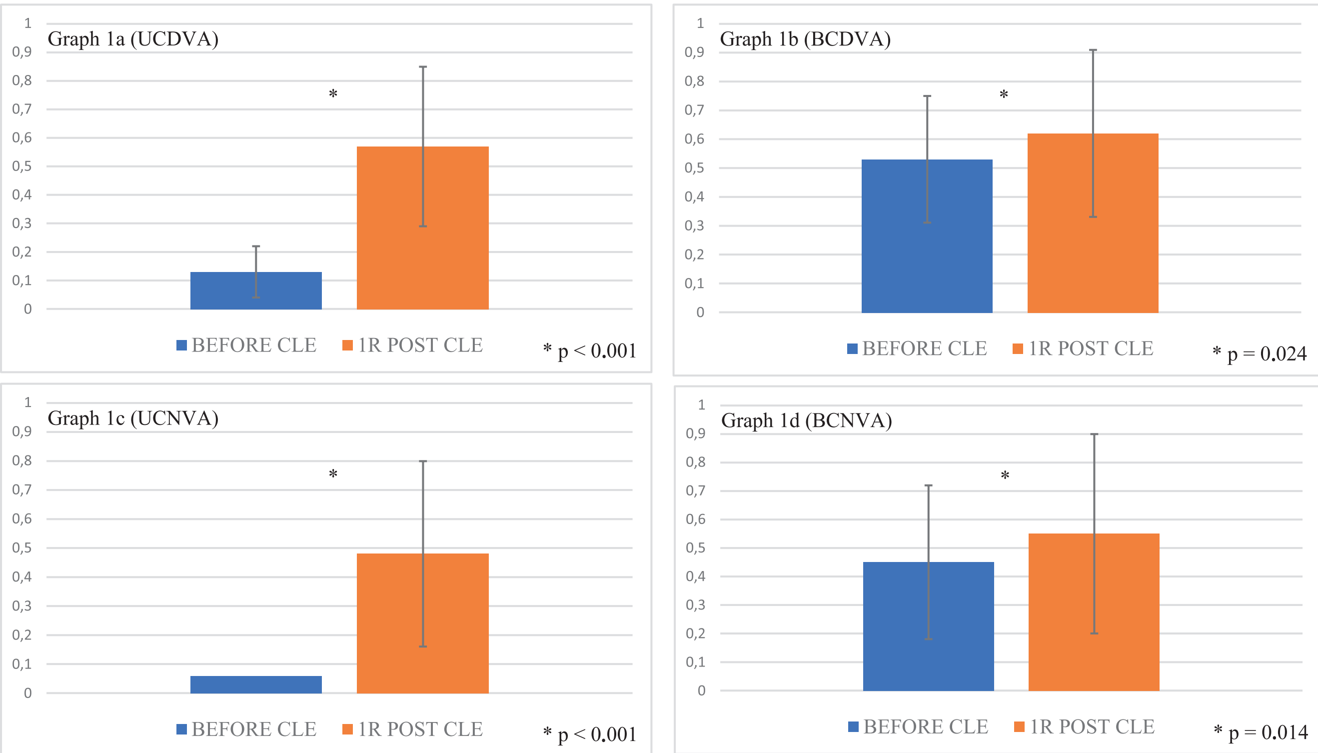
+30.1 ±3.35 SE, with a maximum of +39 SE and a minimum of +24.5 SE. Of these, 7 diffractive lenses were used (1 Tecnis Symfony ZXR00, 4 AT Lisa tri 839 MP, 1 Fine Vision Trifocal Micro F and 1 Medicontur 677MY), as well as 16 rotationally asymmetric lenses (LS 313 MF 30, Oculentis; 5 toric MF 30 T). The average age of the patients in whom a diffractive lens was implanted was 51.9 years at the time of implantation (47–59). The average age of the patients in whom a rotationally asymmetric lens was implanted was 55.4 years at the time of implantation (44–68).

Each patient signed an informed consent form before the procedure. Before surgery the patients underwent a biometric measurement with the aid of the optical biometric system IOL master 500, and later IOL master 700 (Carl Zeiss Meditech, Germany). According to the length of the eye, in biometry we used the formula Hoffer-Q (AXL < 24 mm), or Holladay (AXL > 24 mm). In the case of implantation of a toric intraocular lens (5x M plus) we used the internet calculation form for toric IOLs (https://www.teleon-toric.com/GB/Intro.aspx).

The patients attended postoperative follow-up examinations at a time interval of 1 month and 1 year after surgery. Refraction was measured by the autorefractometer ARK-1 (Nidek, Japan), corrected and uncorrected near and distance visual acuity were measured with the aid of Snellen charts (LCD optotype CX-1000, Topcon, Japan). Contrast sensitivity was subsequently measured with the LCD optotype CX-1000 (Topcon, Japan). Finally, the patients underwent an examination on the slit lamp LS 220 (Zeiss, Germany).

All the operations were performed at UVEA Mediklinik in Martin. The patients paid for the operations themselves. The corneal incisions were localized in the place of the steepest corneal meridian. The IOL was inserted into the capsular bag through a 2.2 mm corneal incision with the aid of the injector Viscoject 2.2 (Oculentis, Germany), in the case of implantation of a rotationally asymmetric lens with the addition placed at the bottom. If CLE was performed in both eyes, the operation on the second eye was usually performed 1 week after surgery on the first eye.

We recorded change of vision before the surgical procedure and 1 year after the surgical procedure in the following parameters: best uncorrected distance visual acuity (UCDVA), best corrected distance visual acuity (BCDVA), best uncorrected near visual acuity (UCNVA) and best corrected near visual acuity (BCN-



Graph 1 Visual acuity change in all amblyopes before CLE and 1 year after CLE; graph **1a** UCDVA, graph **1b** BCDVA, graph **1c** UCNVA, graph **1d** BCNVA

CLE – clear lens extraction
UCDVA - uncorrected distance visual acuity
BCDVA - best corrected distance visual acuity
UCNVA - uncorrected near visual acuity
BCNVA - best corrected near visual acuity

VA). The statistical analysis of the data was performed with the aid of the software SPSS for Windows (version 19.0, SPSS, Inc.). The distribution of the values in the sample was tested with the aid of a Shapiro-Wilk test. In the absence of normal (Gaussian) distribution, we used a Wilcoxon test for comparison of statistical significance of the differences in visual acuity in the whole group before and after the procedure. For comparison of change of vision between the independent subgroups (type of intraocular lens, presence of strabismus), we used a non-parametric analysis with the aid of a Mann Whitney U test. The level of statistical significance was always the same ($p < 0.05$).

RESULTS

From the group with anisometropic amblyopia we detached a group of patients who had undergone strabismus surgery in the past (n = 7). Before the procedure, the patients with anisometropic amblyopia with or without strabismus did not differ in terms of age (Mann-Whitney test: p = 0.521), sex (Fisher test: p = 0.999) or preoperative SE (unpaired T-test: p = 0.397).

In the entire group of patients (n = 22) with anisometropic amblyopia, a significant improvement in uncorrected distance visual acuity (UCDVA) was achieved before the surgical procedure (SP) and 1Y after SP of 0.13 ±0.09 vs. 0.57 ±0.28 ($p < 0.001$), see Graph 1a, in best corrected distance visual acuity (BCDVA) before SP and 1Y after SP of 0.53 ±0.22 vs. 0.62 ±0.29 (p = 0.024), see Graph 1b, uncorrected near visual acuity (UCNVA) before SP and 1Y after SP of 0.06 ±0.06 vs. 0.48 ± 0.32 ($p < 0.001$), see Graph 1c, and best corrected near visual acuity (BCNVA) before SP and 1Y after SP of 0.45 ±0.27 vs. 0.55 ±0.35 (p = 0.014), see Graph 1d.

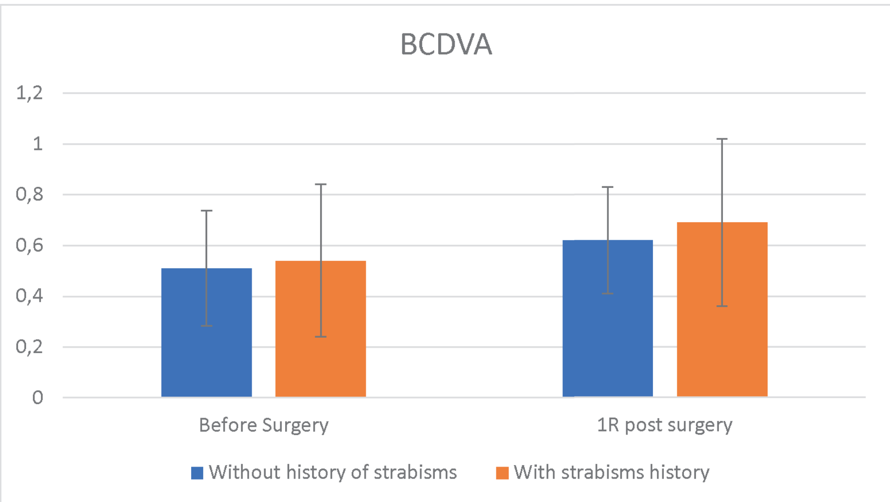
Upon a comparison of change in best corrected visual acuity 1 year after surgery in the group of anisometropic amblyopia with 0.69 ±0.33 (n = 15, p = 0.695) or without a history of strabismus 0.62 ± 0.3 (n = 7, p = 0.373), our analysis did not determine a statistically significant difference between the groups (p = 0.641), see Graph 2.

In the group of patients with purely anisometropic amblyopia (n = 15) upon a comparison of change in best corrected distance visual acuity in the case of diffractive lenses 0.55 ±0.32 (p = 0.512) and rotationally asymmetric lenses 0.66 ±0.28 (p = 0.676), our analysis did not determine a statistically significant difference between the groups (p = 0.854), see Graph 3.

DISCUSSION

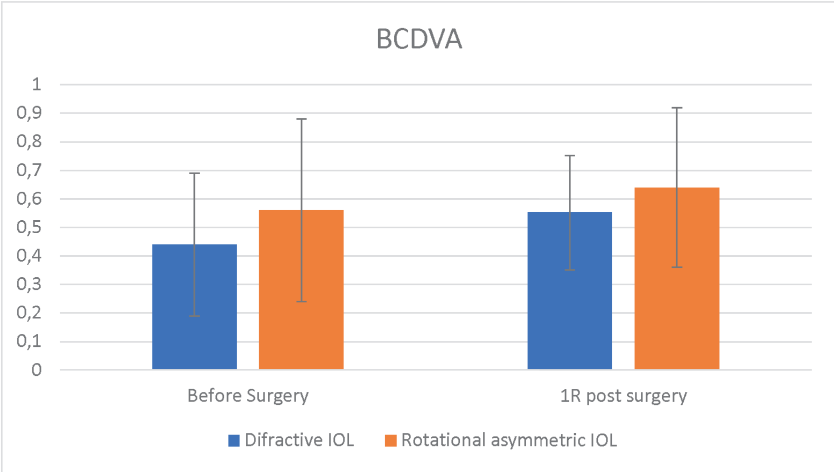
Amblyopia is a pathology with a prevalence of approximately 4% in children and 2% in adults, in Slovakia the epidemiological situation has not been determined. Worldwide the prevalence differs especially in the adult population, according to the availability of treatment in childhood age. It is mostly unilateral, and people with one eye function normally in legislative and formal terms. There are only few occupations for which two healthy eyes are required. However, in the case of trauma the risk of loss of the dominant eye is up to three times greater if the other eye is amblyopic [10].

Therefore, why should we treat amblyopia? The direct advantages cover a potential improvement of visual acuity and stereoscopic vision, and similarly incidental realignment of strabismal eyes with the attainment of improved visual acuity. In adult patients who are accustomed to functioning with one eye, we can improve



Graph 2. Best corrected distance visual acuity (BCDVA), comparison before CLE and 1 year after CLE in anisometropic amblyopes with and without history of strabism (p = 0.641)

CLE – clear lens extraction, p-value – probability value



Graph 3. Best corrected distance visual acuity (BCDVA) before CLE and 1 year after CLE, comparison of rotationally asymmetric multifocal and diffractive trifocal lens (p = 0.854)

CLE – clear lens extraction, p-value – probability value

BCVA in the amblyopic eye in case of trauma or pathology of the healthy eye.

However, in adult age correction alone is unable to reverse amblyopia. In our own case report, we referred to a specific course of treatment with the aid of dioptric training in virtual reality in a 22-year-old amblyopic patient with hypermetropia and anisometropia [11]. In the case of severe amblyopia or astigmatism, it is difficult to achieve accurate correction. Adult patients find it harder to become accustomed to glasses correction, and often see just as well without it. In addition, they have similar problems adjusting to correction by contact lenses.

In the case of myopic anisometropia it is not a problem, even at a younger age, to perform laser refractive surgery or implantation of an ICL. However, patients with myopia are only rarely amblyopic. According to our clinical experience, in hypermetropic patients the situation is different and more complicated – due to the shallow anterior chamber, ICL implantation is a risk from a long-term perspective. Laser refractive procedures are unstable in hypermetropic patients, and accompanied by adverse dysphotopsia. The best long-term and long-proven solution is clear lens extraction. This method provides us with several options for solution today, with the use of monofocal lenses, lenses with an extended depth of focus (EDOF) and trifocal artificial intraocular lenses. The selection of a suitable lens is far more demanding than the operation itself. Due to the reduced contrast sensitivity in amblyopia, and similarly due to the reduced contrast sensitivity of multifocal lenses, their use in CLE for amblyopic patients is contentious. This is always discussed in a personal interview with the patient, and the issue is the degree of amblyopia in each individual, especially near vision, because this is the main reason for surgery in patients undergoing CLE.

In our study, the visual and refractive results in amblyopic patients following the implantation of multifocal intraocular lenses demonstrated a significant change in uncorrected and corrected visual acuity at a follow-up examination after one year. These results are highly encouraging, and merit further observation, especially with regard to the improvement of best corrected visual acuity by almost one whole row after 1-year, full correction, which could not be achieved with glasses correction. Our results are consistent with a study conducted by Irish authors, who used multifocal rotationally asymmetric lenses [6]. In the subgroup of patients with pure anisometropic amblyopia, visual training could help further, as was the case in our previous study [12].

We consider a weakness of the study to be the use of a small number of trifocal artificial intraocular lenses, as well as the fact that various types were used. However, despite the different manufacturers, we believe that the logic of functioning of diffractive lenses is essentially physically identical, and as a consequence we evaluated them as a single group. No group this size with a similar type of lenses has been published to date. A very important issue contained in my study is that of contrast sensitivity. At the baseline examination we do not regularly examine contrast sensitivity, and as a result we do not have this comparison, which is a great shame.

CONCLUSION

In conclusion we can state that the use of multifocal artificial intraocular lenses is possible in clear lens extraction for amblyopic patients. Bilateral implantation of a multifocal intraocular lens is an effective procedure in anisometropic patients. An improvement of best corrected visual acuity after 1 year of observation is possible upon accurate correction of multifocal lenses also in older patients. In our cohort all the postoperative neuroadaptations were without complications.

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