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COMPARISON OF VISUAL FUNCTION AND SATISFACTION IN PATIENTS WITH ACRYSOF RESTOR SN6AD1 MULTIFOCAL INTRAOCULAR LENSES AND MONOFOCAL INTRAOCULAR LENSES

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✧ ***Aim.*** To compare visual function and satisfaction in patients after implantation of AcrySof ReSTOR SN6AD1 multifocal intraocular lens (IOL), AcrySof SA60AT spherical monofocal IOL, or Akreos AO aspheric monofocal IOL during cataract surgery. ***Materials.*** Overall, 34 patients received SN6AD1 multifocal (group 1, 48 eyes), 19 patients received Akreos AO monofocal aspheric (group 2, 30 eyes), and 13 patients received AcrySof SA60AT monofocal spherical (group 3, 18 eyes) IOL. Patients with multifocal IOL were closely matched for age, sex, and ocular findings with patients who had monofocal IOL implantation. Six months postoperatively, uncorrected/corrected distance visual acuity (UDVA/CDVA), uncorrected intermediate (60 cm) and near (35 cm) visual acuity (UNVA), defocus curve, contrast sensitivity, and a quality-of-life questionnaire were evaluated. Furthermore, independence from glasses and presence of optical phenomena were assessed. ***Results.*** Patients in group 2 had statistically significant increase in UDVA than that in group 1 ($p = 0.037$). There was no significant difference in the mean uncorrected intermediate and best corrected distance visual acuities between the groups. UNVA was better in group 1 than that in groups 2 and 3 ($p < 0.0001$). Photopic contrast sensitivity for high spatial frequencies was better in groups 2 and 3. Glare was reported in 5.9% of patients in group 1. Halos occurred in 32.4% of patients in group 1. No one reported undesirable visual symptoms in groups 2 and 3. ***Conclusion.*** Multifocal IOLs provided higher spectacle independence and satisfactory functional vision over a broad range of distances but were associated with increased subjective visual symptoms and reduced photopic contrast sensitivity for high spatial frequencies and distance visual quality compared with monofocal IOLs.

✧ ***Key words:*** cataract surgery; quality of vision; AcrySof ReSTOR SN6AD1 multifocal intraocular lens.

СРАВНЕНИЕ ЗРИТЕЛЬНЫХ ФУНКЦИЙ И СТЕПЕНИ УДОВЛЕТВОРЕННОСТИ КАЧЕСТВОМ ЗРЕНИЯ У ПАЦИЕНТОВ ПОСЛЕ ИМПЛАНТАЦИИ МУЛЬТИФОКАЛЬНОЙ ИОЛ ACRYSOF RESTOR SN6AD1 И РАЗЛИЧНЫХ МОДЕЛЕЙ МОНОФОКАЛЬНЫХ ИОЛ

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✧ ***Цель.*** Сравнение зрительных функций и степени удовлетворенности качеством зрения у пациентов после имплантации AcrySof ReSTOR SN6AD1 с аддидацией + 3,0 D (Alcon), монофокальной асферичной ИОЛ Akreos AO (Bausch & Lomb) и монофокальной сферичной ИОЛ AcrySof SA60AT (Alcon). ***Материалы.*** Все обследуемые пациенты были разделены на три группы. В первую группу были включены 34 пациента (48 глаз), которым была имплантирована ИОЛ AcrySof ReSTOR SN6AD1 с аддидацией + 3,0 D (Alcon). Вторую группу составили 19 пациентов (30 глаз) с монофокальной асферичной ИОЛ Akreos AO (Bausch & Lomb), третью группу — 13 пациентов (18 глаз) с монофокальной сферичной ИОЛ AcrySof SA60AT (Alcon). Распределение обследуемых по полу и возрасту в группах статистически значимо не различалось. Через 6 месяцев после операции всем пациентам проводилось исследование остроты зрения вдаль без коррекции и с коррекцией, остроты зрения на среднем расстоянии (60 см) и вблизи (35 см) без коррекции, контрастной чувствительности, устойчивости остроты зрения к дефокусировке монокулярно, удовлетворённости качеством зрения с помощью опросника VFQ-25, а также по наличию жалоб на дисфотопсии и степени независимости от очковой коррекции на разных расстояниях. ***Результаты.*** Острота зрения вдаль без коррекции была статистически значимо выше у пациентов второй группы по сравнению с пациентами первой группы ($p = 0{,}037$). Острота зрения вдаль с коррекцией, а также на среднем расстоянии без коррекции статистически значимо не отличалась во всех группах ($p > 0{,}05$). Острота зрения вблизи без коррекции была статистически значимо выше у пациентов первой группы, чем в группах 2 и 3 ($p < 0{,}0001$). У пациентов первой группы было выявлено статистически значимое ($p < 0{,}05$) снижение контрастной чувствительности в пределах высоких пространственных частот (5–18 цикл/градус) в фотопических условиях, по сравнению с пациентами второй и третьей групп. В первой группе 5,9 % (2 человека) предъявляли жалобы на повышенную слепимость и 32,4 % (11 человек) — на появление ореола вокруг точечных источников света (гало-эффект). Никто из пациентов второй и третьей групп данные оптические феномены не отмечал. ***Выводы.*** Мультифокальная ИОЛ обеспечивает высокие зрительные функции и бóльшую независимость от очковой коррекции по сравнению с монофокальными ИОЛ, а наличие нежелательных оптических феноменов и снижение контрастной чувствительности на высоких частотах не оказывают значительного влияния на удовлетворённость пациентов качеством зрения.

✧ ***Ключевые слова:*** хирургия катаракты; качество зрения; мультифокальная ИОЛ AcrySof ReSTOR SN6AD1.

INTRODUCTION

The maximum complete restoration of visual function that enables patients to dispense with spectacle correction at different distances is one of the actual problems of modern cataract surgery.

There are several surgical methods for correcting presbyopia, namely the implantation of monofocal intraocular lenses (IOLs) on the principle of monovision [20], the implantation of various models of multifocal and accommodating IOLs, and keratorefractive surgeries in which a multifocal corneal profile is created. However, a number of patients with monofocal pseudophakia have been known to be able to dispense with glasses because they have sufficiently high distance and near visual acuity [15].

At present, multifocal IOLs are becoming more popular for correcting presbyopia [3] because of the improvement of optics as well as high demands of patients for the restoration of visual function. There are various multifocal IOLs, among which the AcrySof ReSTOR SN6AD1 model with ADD power of +3.0 diopters (D) has been widely used [4]. This lens contains hydrophobic acrylic with a high degree of biological compatibility with the tissues of the eye.

The AcrySof ReSTOR SN6AD1 with ADD power of +3.0 D, which is a diffractive–refractive IOL, provides significantly better visual acuity at a short distance, independence from spectacle correction, and favorable social and psychological effects in terms of quality of life than monofocal IOLs [8, 16].

However, the implantation of multifocal IOLs is associated with the presence of adverse effects, such as low intermediate visual acuity, decrease in contrast sensitivity, presence of dysphotopsia (halo effect and increased glare), and need for neuroadaptation [1, 11, 13, 14, 19, 21]. In addition, high sensitivity of this IOL to decentration and to the width of pupil should also be considered [2, 6, 18].

AIM OF THE STUDY

We aimed to compare visual function and degree of satisfaction with visual quality in patients after the

implantation of AcrySof ReSTOR SN6AD1 with ADD power of +3.0 D (Alcon), of monofocal aspherical IOL Akreos AO (Bausch & Lomb), and of monofocal spherical IOL AcrySof SA60AT (Alcon).

MATERIALS AND METHODS

The study included 66 patients (96 eyes) who underwent cataract surgery in the City general hospital no. 2. Age ranged from 42 to 86 years, and the patients included 45 women (mean age, 66.9 ± 11.3 years) and 21 men (66.1 ± 9.1 years). Depending on the type of implanted IOL, the patients were divided into three groups, namely group 1, 34 patients (48 eyes) who were implanted with an AcrySof ReSTOR SN6AD1 with ADD power of +3.0 D (Alcon); group 2, 19 patients (30 eyes) implanted with a monofocal aspherical IOL Akreos AO (Bausch & Lomb); and group 3, 13 patients (18 eyes) implanted with a monofocal spherical IOL AcrySof SA60AT (Alcon).

The difference in the distribution of patients by gender and age in the groups was not statistically significant ($p > 0.05$).

All patients underwent a comprehensive ophthalmological examination before the surgery. Exclusion criteria included the presence of corneal astigmatism of ≥1.0 D, irregular astigmatism, and other ophthalmic diseases before the surgery.

IOL was calculated using the optical biometry method (IOL Master, Carl Zeiss, Germany). The target refraction was emmetropia. Phacoemulsification with implantation of IOL was performed through a 2.2-mm corneal tunnel using the INFINITI (Alcon) system. There were no intra- or postoperative complications in any patient.

The patients were examined the next day and at one week, one month, and six months after the surgery. For a number of patients, the postoperative follow-up period was 1–4 years. Statistical processing of the data obtained after a complete examination was performed 6 months after the surgery.

To evaluate visual function and subjective satisfaction with visual quality, the following research methods were used:

1. Evaluation of uncorrected/corrected distance visual acuity (UDVA/CDVA), uncorrected intermediate visual acuity (60 cm), and uncorrected near visual acuity (UNVA; 35 cm) (according to tables).
2. Study of the stability of visual acuity for monocular defocus.
3. Study of contrast sensitivity (Atlas on visocontrastoperimetry).
4. Subjective evaluation of visual function and satisfaction with visual quality was determined using the NEI VFQ-25 (National Eye Institute Visual Function Questionnaire, USA) as well as by the presence of complaints regarding dysphotopsia and degree of independence from spectacle correction at different distances. For statistical processing of data, the IBM SPSS Statistics program was used. The distribution normality was evaluated and the equality of variances of the analyzed samples was checked. To calculate the significance of differences between the compared groups, the single-factor analysis of variance was used (for distributions that differ from the normal, the Kruskal-Wallis test was used), χ^2 Pearson's test.

RESULTS AND DISCUSSION

Calculation of the optical power of multifocal IOL was made as accurately as possible for emmetropia (±0.25 D), while that of monofocal IOL was made with a slight deviation from emmetropia toward myopia. Target refraction (emmetropia) with a deviation of 0.5 D was achieved in 93% of the patients in group 1 and in 83% of those in groups 2 and 3.

Six months after the surgery, UDVA at 0.8 and above was observed in 91.7% of the examined patients of group 1 and in 100% and 88.8% of those in groups 2 and 3, respectively. UNVA at 0.5 and above was observed in 100% of the examined patients in group 1 and in 39.9% and 44.5% of those in groups 2 and 3, respectively.

At an average distance (60 cm), UDVA of 0.5 and above was achieved in 87.4%, 80%, and 94.4% of the examined patients in groups 1, 2, and 3, respectively. Visual acuity data of the patients in the three groups at different distances are presented in Table 1.

UDVA was significantly higher in the patients of group 2 than in those of group 1 ($p = 0.037$). CDVA as well as uncorrected intermediate visual acuity were not statistically significant across the groups ($p > 0.05$). UNVA was significantly higher in patients of group 1 than in those of groups 2 and 3 ($p < 0.0001$). In patients implanted with monocular or binocular IOL, there were no statistically significant differences in visual acuity at different distances in the three groups.

Patients were tested 6 months after the surgery for the stability of visual acuity to defocus by sequentially applying converging and divergent lenses with 0.5 D increments. Based on the results of the studies, graphs of visual acuity versus the power of defocusing lenses were plotted and analyzed (Fig. 1).

Table 1

Uncorrected/corrected distance visual acuity (UDVA/CDVA), uncorrected intermediate visual acuity, and uncorrected near visual acuity (UNVA) in three groups ($M \pm \sigma$)

Таблица 1

Острота зрения вдаль с коррекцией и без коррекции, на среднем расстоянии и вблизи без коррекции у пациентов сравниваемых групп ($M \pm \sigma$)

Patient group	Distance visual acuity		Uncorrected intermediate visual acuity (60 cm)	UNVA (35 cm)
	UDVA	CDVA		
Group 1 (ReSTOR SN6AD1)	0.93 ± 0.11	1.03 ± 0.10	0.67 ± 0.21	0.94 ± 0.10
Group 2 (Akreos AO)	1.01 ± 0.14	1.06 ± 0.11	0.60 ± 0.20	0.41 ± 0.20
Group 3 (SA60AT)	0.96 ± 0.17	1.05 ± 0.11	0.72 ± 0.20	0.44 ± 0.20

Defocusing curve for the examined patients of group 1. The maximum width of focal zone at a low (10%) resolution corresponding to visual acuity of 0.1 was 9.22 ± 1.48 D, whereas that at 50% resolution was 4.75 ± 0.88 D. The maximum stability dip corresponds to −1.5 D, and the maximum lift is 2.5 D.

Defocusing curves for the examined patients of groups 2 and 3. The presence of one peak corresponding to distance visual acuity is indicative. The maximum width of focal zone at a low (10%) resolution was 8.27 ± 2.32 D and 8.0 ± 2.14 D, whereas that at 50% resolution was 3.14 ± 0.48 D ($p < 0.001$) and 3.25 ± 0.50 D ($p < 0.008$) for groups 2 and 3, respectively.

Analysis of the defocusing curves in the patients of group 1 explained the presence of higher values of intermediate visual acuity for binocular implantation of IOLs in a number of patients (Fig. 2).

Thus, the presence of emmetropia in one eye enables patients to obtain higher values of distance and near visual acuities, and a small hypermetropic shift (0.5 D) in the other eye enables patients to achieve higher values of intermediate visual acuity.

Conversely, increasing the depth of focus, which is a feature of multifocal IOLs, naturally decreases contrast sensitivity.

In our study, contrast sensitivity in all the three groups was checked in each eye under photopic conditions using special maps with a spatial frequency of 0.37–18 cycles/degree, which are part of the atlas

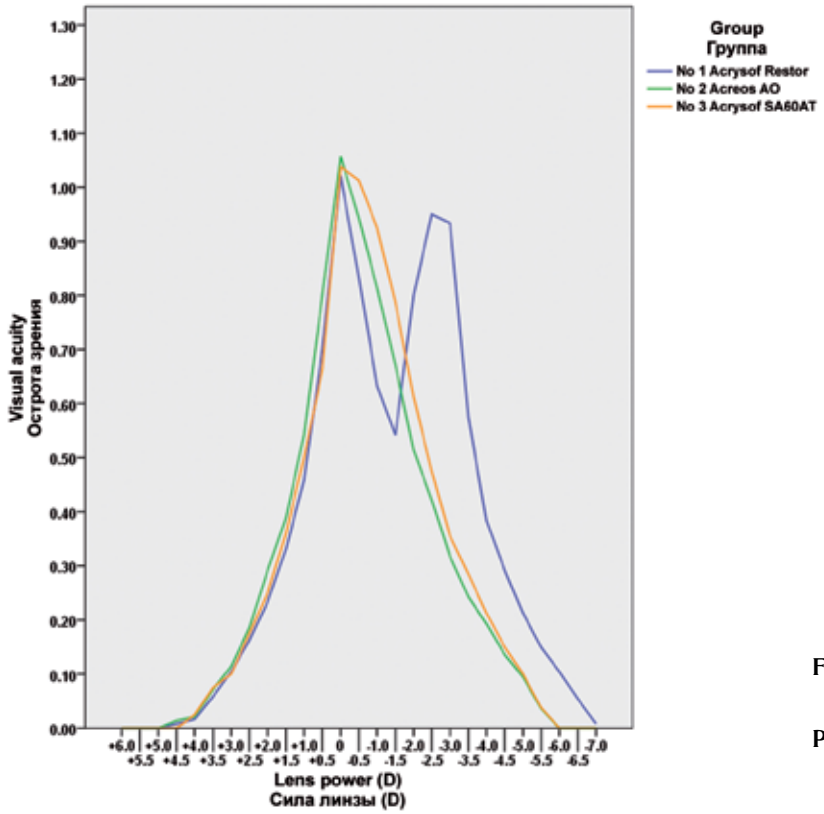

Fig. 1. Defocus curves in three groups of patients

Рис. 1. Графики дефокусировки остроты зрения у пациентов трёх групп

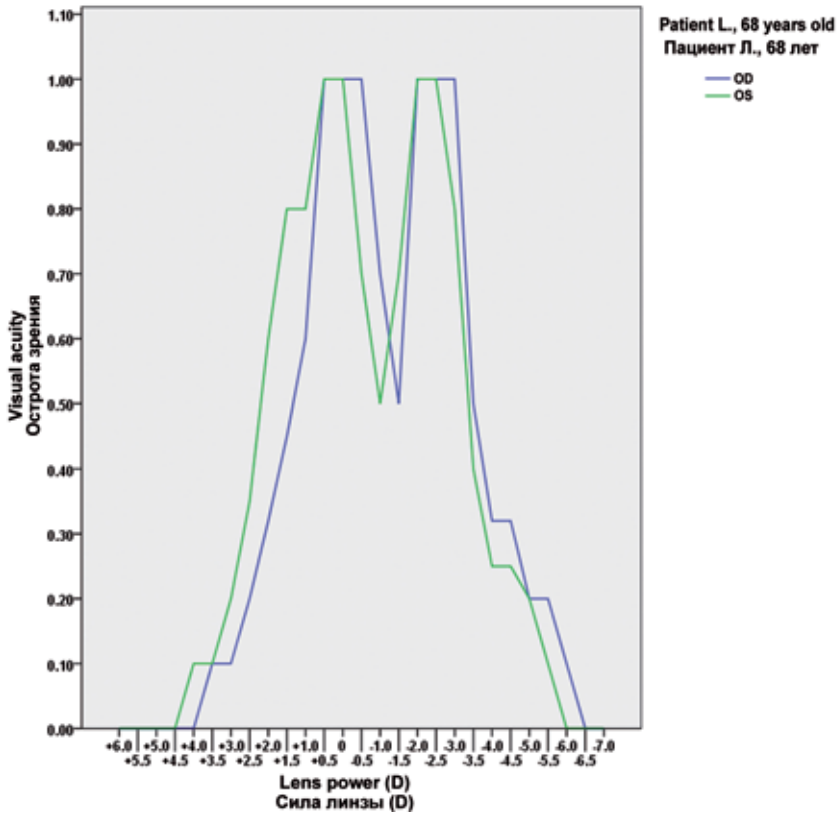

Fig. 2. Defocus curves in binocular implantation of AcrySof ReSTOR SN6AD1 IOL with +3.0 D add and mild anisometropia

Рис. 2. График дефокусировки остроты зрения при бинокулярной имплантации ИОЛ AcrySof ReSTOR SN6AD1 с аддидацией +3,0 D при наличии небольшой анизометропии

on visocontrastoperimetry. For each map, a threshold value of contrast sensitivity in percentage of safety relative to the standards for a given frequency was determined [5]. Contrast sensitivity diagrams were plotted for different spatial frequencies (Fig. 3).

According to visocontrastoperimetry, a statistically significant ($p < 0.05$) decrease in contrast sensitivity within high spatial frequencies (5–18 cycles/degree) was revealed under photopic conditions in the patients of group 1 than in those of groups 2 and 3 (Fig. 3), which is due to the separation of the light flux into two focuses and a decrease in the light intensity focused on the retina as a consequence of structural features of the multifocal IOL optics.

Among the patients, 88.2% (30) of group 1 and 15.4% (2) of group 3 ($p < 0.0001$) never used reading glasses; 2.9% (1) of group 1 and 69.2% (9) of group 3 required spectacle correction for near visual acuity on a regular basis. In group 2, all patients periodically (21.1%) or permanently (78.9%) used reading glasses.

At an intermediate distance, such as working on a computer, using a cell phone, and determining the time on a wristwatch, 91.2% (31) patients of group 1, 52.6% (10) of group 2 ($p < 0.001$), and 76.9% (10) of group 3 ($p > 0.05$) reported that they have never used glasses.

In total, 79.4% (27) patients of group 1 and 15.4% (2) of group 3 never used glasses.

Thus, a number of patients in group 3 with high values of distance visual acuity exhibited a visual acuity sufficient for working at an intermediate and near distance and also exhibited independence from glasses. The ability of the pseudophakic eye to have a clear vision at different distances is differently explained by different authors; some authors believe that this is due to the peculiarities of the optical system (presence of a number of aberrations of lower and higher order) [9, 12], and others associate an increase in the depth of focus with the pupil diameter [10]. It has also been revealed that the implantation of an aspheric IOL provides approximately 0.5 D lower depth of focus and lower values of near visual acuity than that of a spherical IOL because of spherical aberrations [17]. However, it is almost impossible to accurately predict this effect prior to the surgery.

No difficulties in driving a car during the daytime were observed among the patients of the three groups. Driving, going downstairs, etc. in low light-

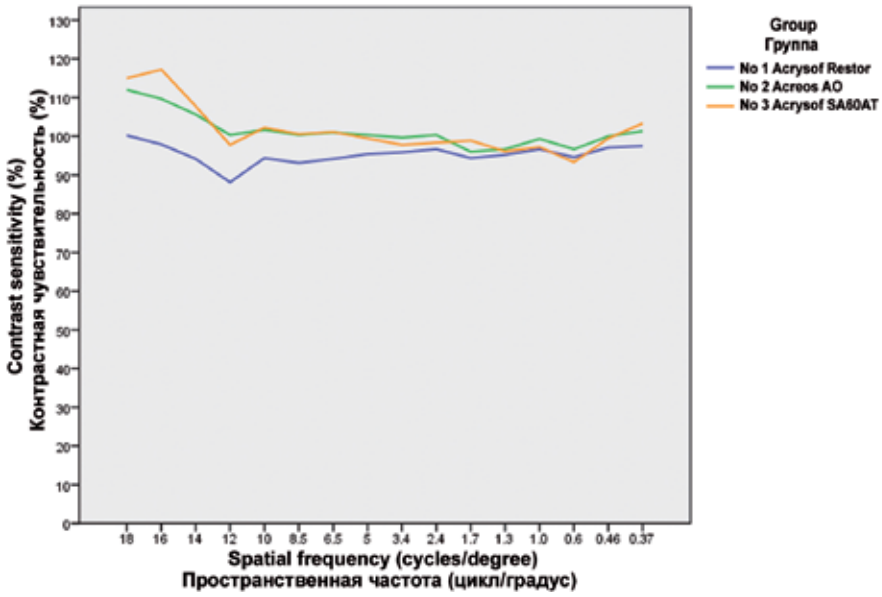

Fig. 3. Photopic contrast sensitivity for various spatial frequencies (cycles/degree) between groups

Рис. 3. Показатели контрастной чувствительности в фотопических условиях для разных пространственных частот (цикл/градус) по группам

ing or at night caused minor difficulties in 17.6% (6) patients of group 1, 5.3% (1) of group 2, and 7.7% (1) of group 3 ($p > 0.05$).

In group 1, 5.9% (2) patients complained of increased glare and 32.4% (11) complained of the appearance of a halo around point light sources (halo effect) after the surgery. These optical phenomena as well as the reduction of contrast sensitivity are explained by the peculiarities of the light separation in the eye with multifocal IOLs. These optical phenomena were of an unexpressed nature, and the subjects did not experience discomfort in their presence. None of the patients of groups 2 and 3 reported these optical phenomena.

There were no statistically significant differences in the subjective assessment of vision in the three groups (Table 2).

According to the questionnaire VFQ-25, high satisfaction with visual function and quality of life was obtained in all the patients of all groups [group 1, 92.58 ± 5.86; group 2, 89.85 ± 6.67; and group 3, 91.12 ± 4.65 ($p > 0.05$)].

Such a dramatic result in the three groups and the absence of a statistically significant difference are associated with different expectations of outcomes of the surgery. Patients implanted with multifocal IOLs, as a rule, aimed at higher rates of visual function and vision quality after the surgery than those implanted with monofocal IOLs [7]. In addition, the degree of satisfaction with the results of the surgery is influenced by the financial costs associated with the acquisition of a multifocal IOL. Considering that the expectations of the examined groups 2 and 3 did not include the achievement of spectacle independence for near visual acuity, the level of satisfaction with visual function and quality of life of patients implanted with monofocal IOLs after the surgery was not less than that in patients implanted with multifocal IOLs.

Table 2

Patient-reported visual acuity in the three groups

Таблица 2

Субъективная оценка зрения пациентами трёх групп

Vision of both eyes	Group 1 (n = 34)	Group 2 (n = 19)	Group 3 (n = 13)
Excellent, %	23.6	5.3	23.1
Good, %	67.6	68.4	69.2
Satisfactory, %	8.8	26.3	7.7

CONCLUSIONS

The multifocal IOL AcrySof ReSTOR SN6AD1 provides high visual acuity at all distances and greater spectacle independence than monofocal IOLs, and the presence of adverse optical phenomena and reduction of contrast sensitivity at high frequencies do not significantly affect patient satisfaction with visual quality.

Minor anisometropia in patients with binocular implantation of multifocal IOLs can improve intermediate visual acuity values and thereby improve the degree of satisfaction with visual quality in these patients.

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