

# Effect of High-Order Aberrations and Satisfaction on Cataract Patients Implanted with Four Types of AcrySof Blue Light Filtering Intraocular Lens

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## Abstract

**Objective:** The objective is to evaluate the visual acuity, high-order aberrations and satisfaction in the cataract patients with the implantation of different types of AcrySof blue light filtering intraocular lens, which would provide the clinical guidance for the selection of individualized intraocular lens. **Methods:** From January 2019 to December 2020, the patients with age-related cataract in Guangzhou Red Cross Hospital were equally randomized to be divided into four groups. 20 patients (20 eyes) were implanted with AcrySof (SN60WF), which was the blue light filtering single focus group; 20 patients (20 eyes) were implanted with blue light filtering aspheric multifocal intraocular lens (AcrySof ReSTOR IOL +3.0D, SN6AD1), which was the multifocal intraocular lens group; 20 patients (20 eyes) were implanted with aspheric astigmatism correction intraocular lens (Toric SN6AT), which was the astigmatism group; 20 patients (20 eyes) were implanted with blue filtering aspheric multifocal astigmatism correction intraocular lens (AcrySof ReSTOR IOL +2.5D IQ, SV25T0), which was the ART group. Three months after the operation, the patients were followed up with slit lamp to check the visual acuity, including uncorrected distance visual acuity (UCDVA), uncorrected near visual acuity (UCNVA), best corrected distance visual acuity, (BCDVA); the questionnaire surveys on the satisfaction of different intraocular lens implantation (far and near vision, glare, halo and abnormal visual symptoms); the iTrace visual function analyzer was used to check the total high-order aberrations (spherical aberration, wisdom aberration and Clover aberration) in the 3 mm pupil diameter. **Results:** Three months after cataract surgery, Amer-

ican Simplified version of questionnaire survey showed that the scores of near removing glasses in the multifocal group and the ART group were significantly better than those in the single focus group and the astigmatism group ( $P < 0.05$ ); there was no significant difference in the satisfaction of far removing glasses, glare and halo in each group ( $P > 0.05$ ). Three months after cataract surgery, there were statistically significant differences about UCDVA, BCDVA and UCNVA among the four groups ( $F = 18.189$ ,  $P < 0.001$ ), the UCNVA in the multifocal group and ART group was significantly better than that in the single focus group and the astigmatism group ( $P < 0.01$ ). The difference of higher-order aberrations (total higher-order aberrations, wisdom aberrations, spherical aberrations, clover aberrations) was no statistically significant among the four groups ( $P > 0.05$ ). **Conclusion:** Different types of AcrySof blue light filtering intraocular lens implantation could improve the far vision and satisfaction of cataract patients, without different higher-order aberrations. Multifocal intraocular lens and ART intraocular lens could significantly improve the far vision of patients and reduce the dependence on near glasses.

## Keywords

Cataract, Intraocular Lens, High-Order Aberrations, Blue Light Filtering

## 1. Introduction

With the aging of the population, there were more and more age-related cataract patients. At present, according to the visual quality requirements of different cataract patients, different types of intraocular lens implantation could be selected, so as to achieve the requirements of accurate refractive cataract surgery.

With the continuous improvement of intraocular lens (IOL) materials and manufacturing technology, the continuous upgrading of surgical equipment, and the development of surgical technology, cataract surgery has been upgraded from simple vision restoration to the refractive cataract surgery stage in pursuit of higher visual quality, which not only meets the long, medium and near vision pursuit of cataract patients, could also meet the need of preventing blue light and correcting astigmatism in cataract patients [1]. However, the higher-order aberrations of lens are positively correlated with age and increase with age [2]. In recent years, with the application of wavefront aberration technology in the field of ophthalmology, the use of wavefront aberrometer to detect the high-order aberrations produced by intraocular lens could objectively evaluate the optical visual quality of different AcrySof IOLs [3]. Therefore, the high-order aberrations and satisfaction of higher-order aberrations with the implantation of different blue light filtering intraocular lens could be evaluated by questionnaire survey and iTrace, which could provide a theoretical basis for individualized selection of intraocular lens for cataract patients.

## 2. Materials and Methods

### 2.1. Research Population

From January 2019 to December 2020, 80 patients (80 eyes) with age-related cataract underwent phaco combined with intraocular lens implantation, including 30 male patients (30 eyes) and 50 female patients (50 eyes), aged 60 - 90 years, in Guangzhou Red Cross Hospital. They were equally randomized to divided into four groups. 20 patients (20 eyes) were implanted with AcrySof (SN60WF), which was the blue light filtering single focus group; 20 patients (20 eyes) were implanted with a blue light filtering aspheric multifocal intraocular lens (AcrySof ReSTOR IOL +3.0D, SN6AD1), which was the multifocal intraocular lens group; 20 patients (20 eyes) were implanted with aspheric astigmatism correction intraocular lens (Toric SN6AT), which was the astigmatism group; 20 patients (20 eyes) were implanted with blue filtering aspheric multifocal astigmatism correction intraocular lens (AcrySof ReSTOR IOL +2.5D IQ, SV25T0), which was the ART group.

Exclusion criteria: 1) which were surgical complications (abnormal pupil, rupture of lens capsule, inability to implant intraocular lens, posterior capsule opacification, lens deviation, cystoid macular edema, etc.); 2) Severe dry eye, corneal disease, previous history of corneal refractive surgery or internal eye surgery, fundus diseases, optic neuropathy, uveitis, ocular trauma, etc.; 3) One eye had undergone cataract surgery and intraocular lens implantation.

### 2.2. Routine Examination before Operation

Preoperative examinations included uncorrected far vision, best corrected far vision, intraocular pressure, slit lamp test, fundus examination, IOL Master examination, and iTrace examination.

### 2.3. Operation Method

All operations were performed by experienced surgeons. Cataract phacoemulsification was performed routinely. Different types of intraocular lenses were implanted into the capsular bag (Alcon Company, USA). Astigmatic and ART intraocular lenses were implanted. The axial position of intraocular lens was positioned preoperative, the viscoelastic agent was removed in the capsular bag and behind the IOL, the target axis of the IOL was adjusted, and the optical part of the IOL was pressed gently to adhere to the posterior capsule finally.

### 2.4. Follow-Up

All patients were checked at 1 week, 1 month, 3 months and 6 months after operation, including visual acuity, intraocular pressure, slit lamp and fundus examination. Three months after operation, UCDVA and BCDVA were checked by international standard logarithmic visual acuity chart; the uncorrected near visual acuity (UCNVA) was checked by jeger near visual acuity chart.

## 2.5. The Questionnaire Survey of Visual Acuity

The American simplified version of the “quality of life questionnaire after multifocal IOL implantation” was used to investigate the condition of lens removal, symptoms of discomfort and surgical satisfaction, and the data were recorded. A questionnaire survey was conducted in three months after cataract surgery in each group, including the dependence of patients on glasses, halo and glare (Table 1).

## 2.6. iTrace Aberrometer Examination

Three months after the operation, the patient sat down in the dark room, placed his mandible on the mandibular pad, watched the red light spot indicator light in the center of placido disc, asked the patient to open his eyes as much as possible, and collected the data of 3.0 mm pupil diameter, and repeated the measurement and examination for 3 times in each eye. The total higher-order aberration, spherical aberration, coma and Clover aberration of 3 mm pupil diameter were recorded.

## 2.7. Statistical Methods

SPSS 26.0 was used for statistical analysis, which was  $\bar{x} \pm S$  form, after the normality test, using single factor analysis of variance, chi square test,  $P < 0.05$  as the difference was statistically significant.

## 3. Results

### 3.1. Clinical Baseline Data

There was no significant difference in the clinical baseline data, mainly including gender and age among the groups ( $P > 0.05$ ) (Table 2).

**Table 1.** Visual quality satisfaction questionnaire for patients after cataract surgery.

| Survey  | 4      | 3            | 2            | 1      |
|---|--------|--------------|--------------|--------|
| 1. Do you wear glasses (far vision)?                  | Never  | Occasionally | Often        | Always |
| 2. Do you wear glasses (near vision)?                 | Never  | Occasionally | Often        | Always |
| 3. Do you have glare, light halo phenomenon?          | Never  | Occasionally | Often        | Always |
| 4. How satisfied were you with this cataract surgery? | Always | Often        | Occasionally | Never  |

**Table 2.** The results of the clinical baseline data.

| Group       | Single focus group | Multifocal group | Astigmatism group | ART group | <i>P</i> value |
|-------------|--------------------|------------------|-------------------|-----------|----------------|
| Gender      |                    |                  |                   |           |                |
| Male (n)    | 10                 | 11               | 9                 | 10        | >0.05          |
| Female (n)  | 10                 | 9                | 11                | 10        | >0.05          |
| Age (years) | 66 ± 8.3           | 67 ± 8.8         | 65 ± 8.2          | 62 ± 8.8  | >0.05          |

### 3.2. Slit Lamp Inspection

It was showed that there were no obvious complications after implantation of different types of intraocular lens among the groups by slit lamp on 1 day, 1 week, 1 month and 3 months. The cornea was generally transparent, the depth of anterior chamber was normal, the pupil was normal, the intraocular lens was located in the capsular bag, without obvious displacement and posterior capsule opacification.

### 3.3. Questionnaire Survey

There was significant difference on taking off glasses when near vision among the four groups ( $\chi^2 = 167.688$ ,  $P < 0.001$ ); The multifocal group and ART group were better than the single focus group and astigmatism group on taking off glasses when near vision ( $P < 0.05$ ); There was no significant difference in the degree of satisfaction among the four groups ( $P > 0.05$ ). One patient in the monofocal group complained about light halo during the day and glare at night, one patient in the multifocal group complained about light halo during the day and glare at night, and no patient complained about light halo or glare at night in the ART group. There was no nocturnal movement disorder among the four groups. During the follow-up, it was found that the demand for near vision after cataract surgery was related to the daily living habits and the refractive state of the contralateral eye also affected the lens removal rate (Figure 1).

### 3.4. Visual Acuity

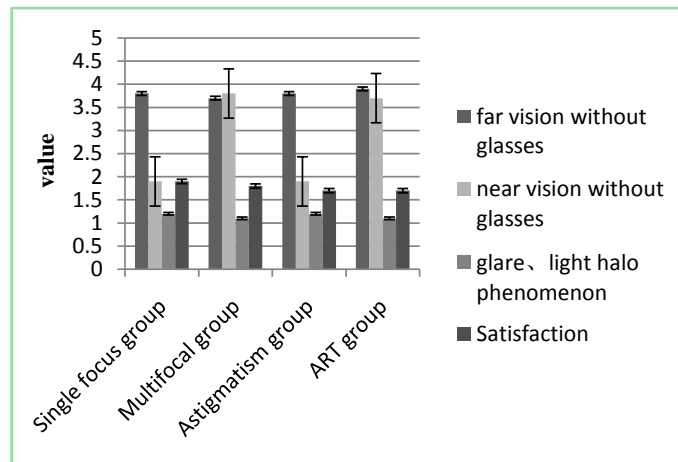
It was significantly different about the UCDVA, BCDVA, UCNVA of the four groups in 3rd months after cataract surgery ( $F = 18.189$ ,  $P < 0.001$ ). The UCNVA of the four groups was significantly different in the third month after cataract surgery ( $P < 0.001$ ). There was no significant difference in UCDVA and BCDVA among the four groups ( $F = 0.191$ ,  $P = 0.902$ ;  $F = 0.393$ ,  $P = 0.759$ ) (Figure 2).

### 3.5. Comparison of Higher-Order Aberrations in the 3 mm Pupil in the Four Groups

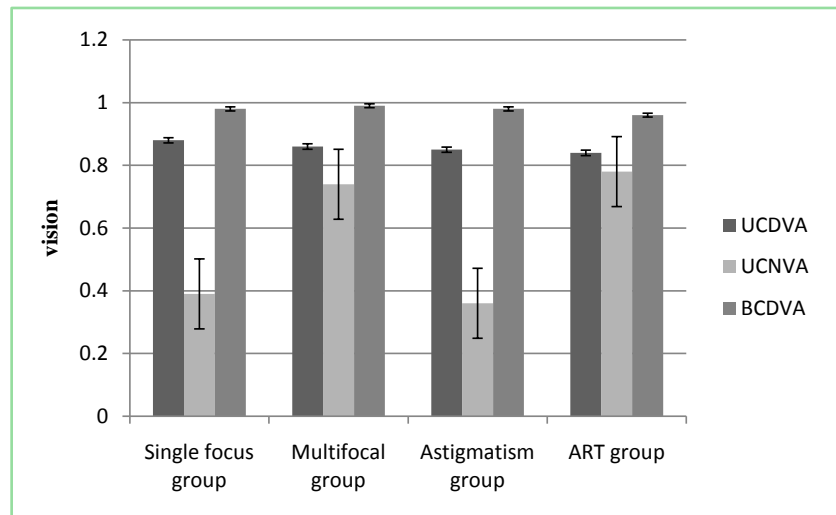
There was no significant difference in the higher-order aberrations (total higher-order aberrations, wisdom aberrations, spherical aberrations, clover aberrations) of the four groups in 3rd months after cataract surgery ( $P > 0.05$ ). There was no significant difference in total higher-order aberrations and spherical aberrations among the groups ( $F = 0.348$ ,  $P = 0.791$ ;  $F = 1.563$ ,  $P = 0.215$ ) (Figure 3).

## 4. Discussion

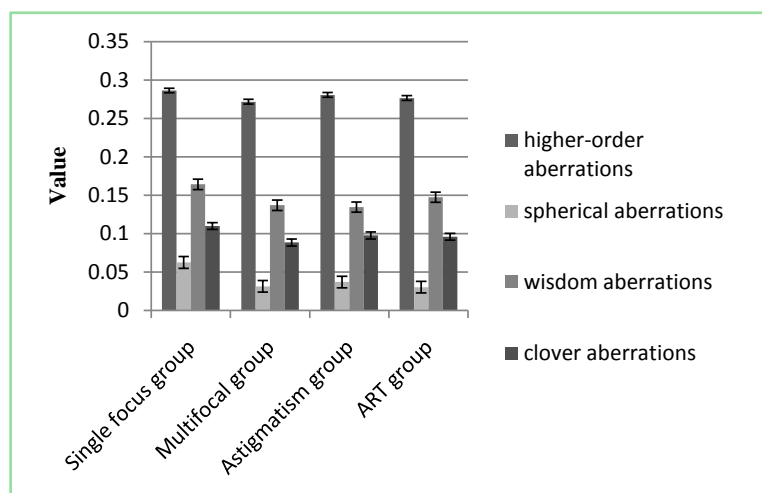
With the continuous improvement and development of intraocular lens material technology, intraocular lens has developed from hard crystal to foldable soft crystal, from colorless to diversified, with the appearance of colored intraocular lens, from spherical crystal to aspheric crystal, from single focus to multifocal



**Figure 1.** Questionnaire survey of postoperative visual quality in cataract patients.



**Figure 2.** Comparison of visual acuity in the four groups after cataract surgery.



**Figure 3.** Comparison of higher-order aberrations in 3 mm pupil diameter in the four groups after cataract surgery.

crystal, from single focus aspheric crystal to astigmatism correction multifocal crystal, The improvement of visual quality of cataract patients after surgery is more and more obvious, not only visible and clear, but also comfortable and persistent [4] [5] [6] [7] [8]. Studies have found that blue light filtering intraocular lens could prevent macular damage caused by blue light, but will the implantation of blue light filtering intraocular lens affect the visual quality and cause visual discoloration in cataract patients? We have not found the phenomenon of visual discoloration and private complaints through questionnaire survey [9] [10] [11].

We found that the far vision and the best corrected far vision were very good in the four different types of foldable blue light filtering intraocular lens, including blue light filtering single focus aspheric intraocular lens (SN60WF), blue light filtering multifocal intraocular lens (SN6AD1), blue light filtering aspheric astigmatism correction intraocular lens (Toric SN6AT), the blue filtered aspheric multifocal astigmatism correction intraocular lens (ART). However, the near vision of the SN6AD1 and ART intraocular lens has obvious advantages; they could provide far vision and near vision. Only a few patients have postoperative glare and halo, but there was no case of visual discoloration. Most cataract patients have good objective distant vision after surgery, but a few patients are still dissatisfied with the visual quality, such as poor night vision, glare, halo and so on. Wavefront aberration is more and more widely used in the clinical application of cataract surgery combined with intraocular lens implantation. Therefore, the application of iTrace system to evaluate the visual quality of intraocular lens after cataract surgery could provide an objective basis for the selection of intraocular lens implantation in cataract surgery [3] [12] [13].

Many studies have found that blue light filtering intraocular lens could filter short wavelength blue light, protect retinal pigment cells, reduce the damage of blue light to retinal pigment epithelium, improve the sleep quality of patients after cataract surgery, reduce the risk of age-related macular degeneration, and reduce visual fatigue and glare [9] [14] [15] [16].

## 5. Conclusion

In conclusion, different types of AcrySof foldable blue light filtering aspheric intraocular lens implantation were safe, and the effect of early visual quality investigation was satisfied. According to different occupational and economic conditions, different distance vision requirements, whether there is regular corneal astigmatism, personalized selection of different types of intraocular lens, could effectively improve the visual quality of different cataract patients after surgery. It is an important personalized pursuit of refractive cataract surgery that is “clear, comfortable and persistent”. The clinical guidance for the selection of individualized intraocular lens still needs study furtherly.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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