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Comparative analysis of visual quality after implantation of Symfony IOL and MF15 IOL

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连续视程人工晶状体和区域折射型人工晶状体植入术后视觉质量的对比分析

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摘要

目的:比较连续视程(Tecnis Symfony)人工晶状体(IOL)和区域折射型(Lentis Comfort LS-313 MF15)IOL植入术后患者的视觉质量。

方法:临床前瞻性研究。收集2021-01/12在我院行白内障超声乳化联合IOL植入术的白内障患者267例(305眼),按植入IOL类型分为Symfony组(A组,160眼)和MF15组(B组,145眼),观察两组患者术后3mo裸眼远视力(uncorrected distance visual acuity, UDVA)(5m)、裸眼中视力(uncorrected intermediate visual acuity, UIVA)(80cm)、裸眼近视力(uncorrected near visual acuity, UNVA)(40cm),离焦曲线,调制传递函数(MTF)和高阶相差(HOAs),包括彗差、球差、三叶草差,进行视觉质量问卷调查(Quality of Vision questionnaire,QoV)。

结果:两组患者术前各参数差异均无统计学意义($P>0.05$)。A组和B组UDVA和UNVA差异无统计学意义($P>0.05$);A组的UIVA高于B组($P<0.05$);A组的MTF值在各个空间频率下均高于B组,差异具有统计学意义($P<0.05$);A组的HOAs低于B组($P<0.05$);术后3mo绘制离焦曲线显示0D处两组视力相似,-0.5D~-2.5D处A组视力优于B组,且在-1.0D和-2.0D处差异有统计学意义($P<0.05$);A组的Qov分数高于B组($P<0.05$);A组出现光晕,星爆等不良视觉干扰现象的频率要高于B组。

结论:MF15和Symfony均提供了稳定的远,近距离视力;与MF15相比,Symfony IOL具有较好的中距离视力,较高的对比敏感度以及较低的HOAs;与Symfony相比,MF15人工晶状具有更少的术后不良视觉干扰现象(光晕,星芒等)。

关键词:Symfony;MF15;视觉质量

Abstract

• AIM: To compare the visual quality in patients after implantation of extended - range - of - vision (Tecnis Symfony) intraocular lens (IOL) and zonal refractive (Lentis Comfort LS-313 MF15) IOL.

• METHODS: A prospective clinical study. Collecting 267 cataract patients (305 eyes) who underwent phacoemulsification combined with IOL implantation surgery in our hospital from January 2021 to December 2021, they were divided into the Symfony group(group A, 160 eyes) and MF15 group (group B, 145 eyes) according to the types of implanted IOL. Postoperative visual acuity were observed at 3mo and included uncorrected distance visual acuity (UDVA, 5m), uncorrected intermediate visual acuity (UIVA, 80 cm), uncorrected near visual acuity (UNVA, 40cm), defocus curve, modulation transfer function (MTF) and high - order aberrations (HOAs), including coma, spherical aberration and trefoil aberration, and conducted the Quality of Vision (QoV) questionnaire.

• RESULTS: There were no significant differences in the preoperative parameters in both groups ($P>0.05$). There was no significant difference between the UDVA and UNVA in groups A and B ($P>0.05$); The UIVA was higher in group A than in group B ($P<0.05$); The MTF value in group A was higher than group B at all spatial frequency, and the difference was statistical significant ($P<0.05$); The HOAs in group A was lower than that in group B ($P<0.05$); Defocus curves were plotted 3mo after the operation suggest that the visual acuity of the two groups was similar at 0D, and the visual acuity of the groups A was better than group B from -0.5D to -2.5D, and there was a statistically significant difference at -1.0D and -2.0D ($P<0.05$). The QoV score in group A was significantly higher than that in group B ($P<0.05$). The frequency of bad visual interference such as halo and starburst was higher in group A than in group B.

• CONCLUSION: Both the MF15 and Symfony can provide

stable distance and near visual acuity. Compared with MF15, Symfony had better intermediate visual acuity, higher contrast sensitivity and lower HOAs. Compared with Symfony, MF15 IOL had less postoperative bad visual interference symptoms (halo, starburst, *etc*).

• KEYWORDS: Symfony; MF15; visual quality
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INTRODUCTION

With the rapid development of cataract surgery technology and the increasing demand for visual quality, cataract surgery has entered the era of refractive surgery. The aim of cataract surgery is to correct presbyopia and obtain clear and comfortable vision. Multifunctional intraocular lenses (MIOLs) emerged in the 1980s to some extent to meet the higher visual needs of patients[1-2]. This study compared the visual quality of patients at 3mo after Symfony and MF15 implantation and evaluated their application effects in order to provide theoretical guidance for the selection of multifunctional IOLs according to the different needs of patients in clinical practice.

SUBJECTS AND METHODS

This study included 267 patients (305 eyes) who received cataract surgery and interested in presbyopia correction. All patients underwent comprehensive ophthalmic examination after admission, including uncorrected distance visual acuity (UDVA), corneal endothelial cell count, axial length, tonometry, slit-lamp evaluation and fundus examination. Inclusion criteria were age 50-75 years, cataract causing a reduction in visual quality, and motivation to remove spectacles. Exclusion criteria were inability to cooperate; Glaucoma, dry eye, oblique amblyopia, and other eye diseases; Previous refractive surgery; And corneal astigmatism higher than 1.0D.

Ethical Approval All patients who met the above criteria were informed of the IOL characteristics and signed informed consent forms. They were willing to follow up regularly and complete relevant ophthalmic examinations to monitor changes in their condition. Meanwhile, the study was approved by the hospital ethics committee.

Surgical Procedure Assessing surgical risk, patients were fully informed of the treatment measures and possible risks, and written informed consent was obtained from the surgery. Routine eye drops of levofloxacin hydrochloride were applied to both eyes 3d before the surgery. The pupil was dilated with compound tropicamide eye drops at 30min before surgery, the operating room was routinely disinfected, and towels were spread. After surface anesthesia was induced a 3.0 mm transparent corneal main incision was made at 1-1.5 mm inside the corneal limbal at the 10-11 point of the patient's surgical eye, and a 15° bayonet was used to make the corneal side incision. A continuous circular capsulorhexis was injected into the anterior chamber; the lens capsulorhexis was symmetrical in the center, with a diameter of 5-6 mm. Water separation and stratification were performed. An ultrasonic emulsification device was used for ultrasonic emulsification, gettering lens nucleus, noting the suction handle residual cortex, suck out into the pouch adhesion agent and implanted MIOLs, makes a sac before IOL optical area boundary, gettering residual adhesion agent, watertight corneal incision, conjunctival sac with dexamethasone spleen eye ointment (standard will be different), and sterile dressing after covering the eye. The doctor's advice was followed after surgery. All surgeries were performed by the same surgeon.

Patient Assessment and Outcome Measures

Patients were followed up in the outpatient department 3mo after surgery, with the examination performed by the same skilled technician operating the system and including the following main observational indicators:

Visual acuity was measured first at the visit. Uncorrected distance visual acuity, uncorrected intermediate visual acuity and uncorrected near visual acuity were measured respectively at 5m, 80cm, 40cm away. Defocus curves were created using a comprehensive optometer, placed in front of the patient's surgical eye, the degree ranging from -4.5D to +2.0D, 0.5D as the span of lens replacement with continuous recording of the visual acuity after placing different lenses and the defocus curve were drawn.

The high-order aberrations (HOAs) and modulation transfer function (MTF) of the whole eye were calculated by using iTrace after the patients adapted to the natural state of the darkroom for 10 min[3].

The Quality of Vision (QoV) questionnaire score can assess dysphotopsia. The QoV is a validated Rasch-adjusted questionnaire and uses the most intuitive pictures to show the dysphotopsia that patients may have, so that patients after cataract surgery can more intuitively understand their symptoms. They are asked to rate 10 dysphotopsia items shown in the photographs and then score each item (0, 1, 2 and 3) in relation to how frequent, severe and bothersome their symptoms are (30 items in total). Responses to the QoV questionnaire were converted to a linear scale (0-100). The higher the Rasch-weighted QoV score, the worse the visual quality[4].

Statistical Analysis Measurement data were presented as mean ± standard deviation, SPSS 26.0 statistical software was used for processing. The independent samples t-test was used for comparison between the groups. Counting data were compared between groups using the Chi-square test. $P<0.05$ was considered statistically significant.

RESULTS

The statistical information and preoperative examination results of the two IOLs were shown in Table 1. There were no significant differences in age, gender, CECC, AL and UDVA between the two groups.

Table 1 Preoperative patient indicators

Parameters	Symfony	MF15	*P*
Eyes	160	145	
Age($\bar{x}\pm s$, year)	66.93±48.01	63.53±4.56	0.397
Gender(Female/Male)	93/67	76/69	0.316
CECC ($\bar{x}\pm s$, mm^2)	2386.04±193.93	2408.94±66.57	0.178
AL ($\bar{x}\pm s$, mm)	22.99±1.13	22.98±0.58	0.862
UDVA ($\bar{x}\pm s$, LogMAR)	0.67±0.19	0.71±0.20	0.111

CECC: corneal endothelial cell count; AL: axial length; UDVA: uncorrected distance visual acuity.

Comparison of postoperative visual acuity between the two IOLs was shown in Table 2. The postoperative visual acuity at 3mo was significantly improved in both groups. There was no significant difference in UDVA and UNVA between the two IOLs ($P>0.05$), however, UIVA in Symfony was better than that in MF15 ($P<0.05$).

Comparison of postoperative defocus curves between the two IOLs was shown in Figure 1. The trend of the defocus curve of the two IOLs was smooth 3mo after the operation; The results showed that the visual acuity of the two groups at 0D was similar, and the defocus curve of group A was better than that of group B from −0.5D to −2.5D, but there was no difference between the two groups from −2.5D to −4.5D.

The comparison of HOAs and MTF between the two IOLs 3mo after surgery showed that the MTF of Symfony was higher than that of MF15 in the whole spatial frequency range from 5 to 30 C/D ($P<0.05$), which also showed that the contrast sensitivity of Symfony was stronger than that of MF15 (Figure 2). The high-order difference in Symfony was lower than that in MF15 ($P<0.05$) (Table 2).

Comparison of postoperative QoV scores between the two IOLs is shown in Table 2. After the operation at 3mo, the QoV score in Symfony was significantly higher than that in MF15 ($P<0.05$). The frequencies of glare, halo, and starburst in Symfony were higher than in MF15 (Figure 3).

Table 2 Comparison of outcomes between the two groups 3 months after operation $\bar{x}\pm s$

Parameters	Symfony	MF15	*P*
UDVA	0.10±0.09	0.10±0.11	0.753
UIVA	0.16±0.14	0.19±0.12	0.027
UNVA	0.34±0.07	0.35±0.16	0.364
HOAs	0.24±0.05	0.28±0.214	0.015
spherical aberration	0.03±0.13	0.04±0.03	0.007
coma	0.08±0.35	0.10±0.70	0.006
Trefoil	0.15±0.40	0.18±0.13	0.013
QoV scores	23.6±3.7	22.0±4.7	0.001

UDVA: uncorrected distance visual acuity; UIVA: uncorrected intermediate visual acuity; UNVA: uncorrected near visual acuity; HOAs: high-order aberrations; QoV: Quality of Vision.

DISCUSSION

The visual quality of patients after cataract surgery is highly dependent on the type of IOL that is implanted. It can be said that the IOL is the most important development in the history of refractive cataract surgery[5]. With the use of computers and other devices, patients have high requirements for far, intermediate, and near visual acuity after cataract surgery; however, most MIOLs can only provide good far and near visual acuity[6]. The two MIOLs selected in this study achieved good patient satisfaction in clinical applications and provided patients with good postoperative visual acuity. Patients generally have a high rate of spectacle independence, but few studies have compared visual quality after implantation.

Symfony is a one-piece, two-loop continuous visual range IOL based on diffraction[7]. The IOL is designed with hydrophobic acrylic material with a crystal diameter of 13.00 mm and an optical surface diameter of 6.00 mm. The front surface is aspheric, and the rear surface has a patented Echelette small-step diffraction grating design. By optimizing the width, height, and profile of the diffraction ladder, phase-length interference of light in different regions can be achieved, thus extending the focus range, extending the focal depth, and turning the focus into the focal line, which provides a high-quality continuous visual range for patients. Furthermore, achromatic diffraction technology can improve contrast sensitivity and reduce uncomfortable reactions, such as glare and halo[8].

MF15 is an MIOL based on refraction, non-rotational symmetry, and the surface-embedded near-area design principle. The IOL is composed of hydrophilic acrylate and has a hydrophobic surface. The upper part is divided into a distal area, and the lower part is divided into a fan-shaped proximal area with a 1.5D near attachment. This design allows the crystal to provide the best visual effect when viewing distant, neutral, and close objects with low incidence of optical side effects[6-9].

Attia *et al* believed that cataract patients could achieve "full-range vision" in a real sense after Symfony implantation by providing good intermediate and near visual acuity on the premise of far vision[10]; Pedrotti[11] noted that Symfony can provide better naked medium and near range vision compared with unifocal IOL. Yoo[12] and Kretz[9] showed that MF15 performed well at intermediate distance visual acuity after cataract surgery in both monocular and binocular patients, which was consistent with our findings. Our results showed

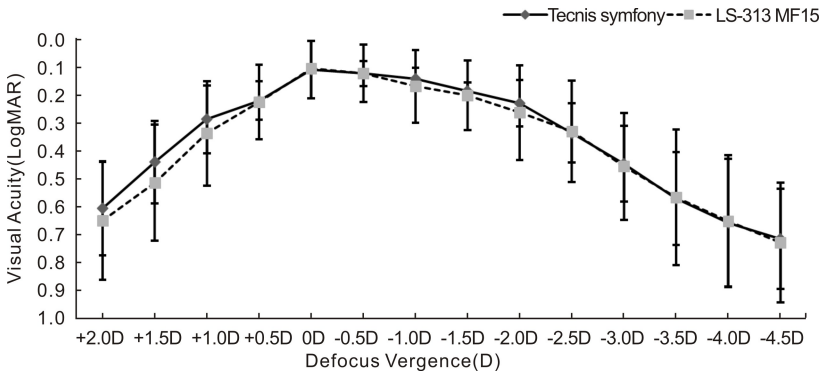

Figure 1 Comparison of defocus curves between the two groups 3mo after operation.

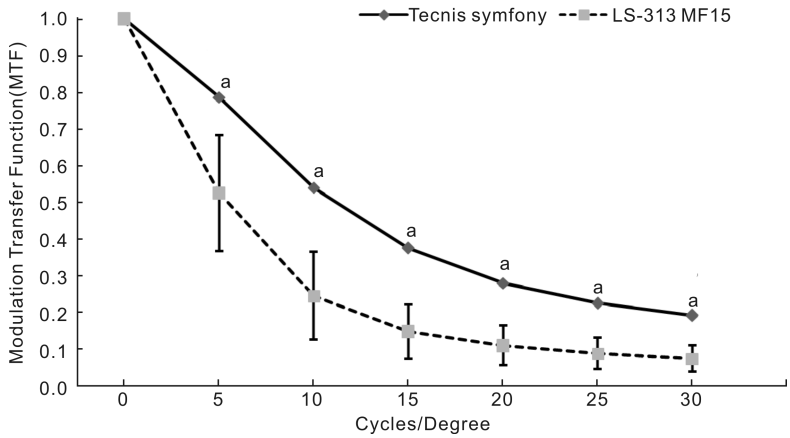

Figure 2 Comparison of MTF between the two groups 3mo after operation [a]$P<0.05$ *vs* MF15.

that both the Lentis Comfort LS－313 MF15 and Symfony provided relatively stable distance and near visual acuity, and Symfony had better intermediate visual acuity than MF15.

The defocus curve can accurately reflect the real visual performance of cataract patients at various distances after surgery, and the measurement of the defocus curve in a large clinical sample is helpful in understanding the function of the IOL, so as to evaluate the postoperative visual expectation of patients. Our results indicate that the defocus curve of Symfony in the range of 0－4.0D shows a smooth trend, which may be related to the patented Echelette diffraction grating design of Symfony.

The significance of the clinical study of MTF values lies in the dynamic expression of contrast sensitivity, and MTF gradually decreases with an increase in spatial frequency. Symfony has been shown to have good contrast sensitivity compared with other MIOLs[13-14], and studies have also shown that compared with diffractive IOL, regional refraction IOLs show better contrast sensitivity. However, the existence of differences may reduce the retinal imaging quality of the regional refractive IOL, resulting in a decrease in its contrast sensitivity. Symfony's patented achromatic technology corrects chromatic aberrations to enhance contrast sensitivity and significantly improves the retinal imaging quality. Our study shows that compared with MF15, Symfony has higher contrast sensitivity at all spatial frequencies.

HOAs include spherical aberrations, coma, trefoil, and other optical defects in refractive systems. Spherical aberrations and coma are the main aberrations that reduce image quality. Vega[15] found some limitations after MIOLs implantation, the most common of which was the induction of undesirable dysphotopsia of varying degrees, such as glare and halo. A study by Millan[16] showed that Symfony had achromatic effects, but further clinical measurements and studies are needed for clarification. Our study showed that Symfony had lower HOAs than MF15.

The results of the questionnaire showed the subjective visual function of cataract patients after surgery. Song showed that compared with unifocal IOL, Symfony had a more serious halo and starburst, while glare did not significantly differ among patients with IOL implantation[2]. Lee[17] believes that the spectacle independence of patients after Symfony implantation is high, but this is at the cost of more glare and halo after surgery. Oshika followed up with cataract patients with MF15 implantation for one year and found that the contrast sensitivity was in the normal range, with less subjective symptoms, less bad visual interference, and high overall satisfaction. The patients who underwent MF15 had good－medium and long－distance visual acuity. Although the near－additional degree of 1.5D was increased in part of the fan－shaped myopia under MF15, the postoperative near vision of the patient was not enough to read small fonts[18]. Our results showed that the satisfaction and spectacle－independent rates of patients after Symfony and MF15 implantation were high. The results of the patients' self－visual quality evaluation showed that Symfony had better visual quality during the day,

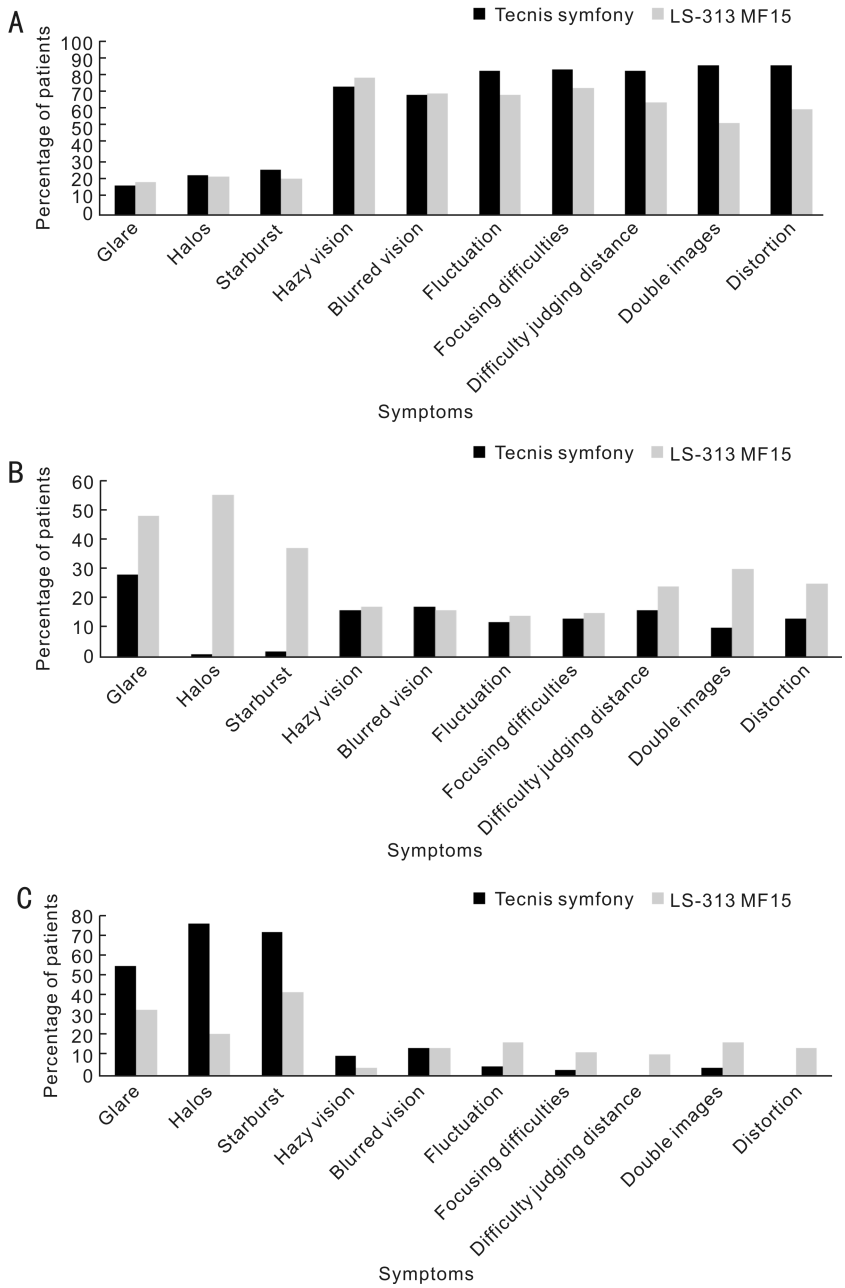

Figure 3 How often did you experience the following symptoms? A: Percentage of patients who answered "Never"; B: Percentage of patients who answered "Occasional"; C: Percentage of patients who answered "Often".

while MF15 performed better at night. The better objective results and subjective daytime visual quality of Symfony may benefit from its unique achromatic diffraction grating design. However, compared with diffractive IOL, regional refractive IOL has a smoother transition region and is less likely to produce optical interference, which may also directly affect the patient's self-subjective evaluation.

At present, the wide use of computers and other devices has led to high requirements for middle-range vision, but most IOLs currently on the market can only provide good distance-range vision and near-range vision but lack intermediate-range vision[19-20]. Symfony and MF15 differ in optics and material design, but both provide excellent and stable distance and intermediate-range vision. Through our analysis, we also found that they have their own advantages and disadvantages in terms of the visual quality of cataract patients after surgery, that patients with IOL implantation experienced a high frequency of adverse visual interference (halo, star, awn, *etc.*), and that some patients reported halo and starburst after Symfony implantation. Under the effect of neural adaptability, most cases of adverse visual interference disappear gradually. In clinical practice, personalized plans can be made according to patients' eye conditions and needs.

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