The Open Ophthalmology Journal

Content list available at: https://openophthalmologyjournal.com

RESEARCH ARTICLE

Visual Performance, Spectacle Independence, Visual disturbances and Patient Satisfaction after Cataract Surgery: Comparison of 2 Diffractive Intraocular Lenses in a Tertiary Hospital

Mohammed Al Fayyadh[1,*], Majed Al Subaie[2], Mohammed El Salamony[2], Abdullah Al Rajhi[3] and Mohanna Al Jindan[4]

[1]*Departement of Ophthalmology, Prince Mutaib Bin Abdulaziz Hospital, Aljouf, Saudi Arabia*
[2]*Departement of Ophthalmology, Dhahran Eye Specialist Hospital, Dhahran, Saudi Arabia*
[3]*Departement of Ophthalmology, Prince Sultan Military Medical City, Riyadh, Saudi Arabia*
[4]*Departement of Ophthalmology, College of Medicine, King Fahad Hospital of the University, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia*

Abstract:

Purpose:

This study aimed to compare the clinical outcomes of the *AcrySof PanOptix* intra-ocular lens and *AT LISA* tri 839MP trifocal IOL, 6 months after cataract surgery.

Patients and Methods:

This retrospective cohort study evaluated patients who underwent bilateral cataract surgery with diffractive IOL implantation. Patients were divided into two groups based on the IOL model implanted (*AcrySof PanOptix* IOL; AT LISA tri 839MP trifocal IOL). Study parameters were noted preoperatively (visual acuity only) and 6 months postoperatively. At the 6-month post-operative visit, both eyes were examined for the following: uncorrected distance visual acuity at far (6 m), uncorrected intermediate visual acuities (UIVA) at 80 cm and 60 cm, near uncorrected visual acuity at 40 cm, incidence of posterior capsule opacification, presence of subjective photic phenomena, in addition to a questionnaire assessing the quality of life and visual function.

Results:

Thirty nine patients (78 eyes) with diffractive IOLs (*AT LISA,* n=23; *PanOptix* n=16) were included. No statistical significance was found between the lenses. The median power of both implanted lenses was 21. Post-operatively, the AT LISA group showed slightly lower median UIVA than the *PanOptix* group at 60 cm and the reverse at 80 cm. A larger number of patients in the *PanOptix* group showed better performance at intermediate activities than in the AT LISA group. Posterior capsule opacification developed in significantly fewer eyes with *PanOptix* (6.2%) than with *AT LISA* (17.4%), none had double vision, and the photic phenomena were found troublesome by >20% of the patients in either group. Overall satisfaction was comparably high.

Conclusion:

Both IOLs had similar and favorable visual outcomes. However, *PanOptix* IOL had better performance at 60 cm in intermediate visual activities.

Keywords: Cataract surgery, Diffractive, Trifocal, Multifocal, AcrySof PanOptix, AT LISA tri 839MP, Visual acuity, Photic phenomena, Spectacle Independence.

Article History	Received: May 23, 2022	Revised: July 5, 2022	Accepted: August 22, 2022

1. INTRODUCTION

The advances in intraocular lens (IOL) technology have made cataract surgery a refractive procedure. Intraocular lens design and characteristics are evolving to improve visual outcomes and patient satisfaction, with the special aim of achieving spectacle independence at all distances after lens surgery [1]. In earlier designs of multifocal IOLs, the goal was to achieve satisfactory far and near vision [2]. As handheld devices, such as computers and tablets, are increasingly used in

* Address correspondence to this author at the Departement of Ophthalmology, Prince Mutaib bin Abdulaziz Hospital, AL jouf, Saudi Arabia;
Tel: +966555389040; E-mail: mohamedalfayad@hotmail.com

day-to-day affairs, the intermediate vision has become a concern for optical manufacturers. Thus, new models of trifocal IOLs were recently developed to address intermediate vision with a third focal point, while maintaining good far and near vision [3 - 7].

Efforts have additionally been made to overcome other limitations of bifocal IOL designs, such as loss of contrast sensitivity or photic phenomena. However, unwanted visual effects, most notably halos and glares, remain a limitation for multifocal IOLs [3 - 7]. Further, visual acuity might not reflect the quality of vision (QOL), owing to the fact that it does not always correspond to other visual aspects. These include photopic phenomena, contrast issues and performance of the IOL in different daily activities. Hence, patients with better acuity may perceive themselves at a disadvantage. Achieving uncorrected optimal visual outcomes with excellent quality of vision remains the aim of lens surgery [8 - 10].

Data on the visual performance of the *AcrySof PanOptix diffractive IOL (Alcon Laboratories, Inc.)* with its newly introduced intermediate focus (60 cm rather than 80 cm) and its comparison with other diffractive IOLs is limited [11 - 16]. The aim of this study was to compare the objective and subjective clinical performances of *PanOptix AcrySof* and *AT LISA tri 839MP* intraocular lenses, six months after cataract surgery. The parameters assessed included visual outcomes, spectacle independence, patient satisfaction and subjective visual disturbances. To the best of our knowledge, this is the first study of its kind in our region.

2. MATERIALS AND METHODS

This retrospective cohort study evaluated patients who underwent bilateral cataract surgery with trifocal IOL implantation was conducted in a single tertiary hospital. The lenses used in this study were *Acrysof IQ Panoptix* and *AT LISA Tri 839MP*. This study was conducted at King Fahad University Hospital (KFHU), Easter Province, Khobar, Saudi Arabia, from September 2019 to October 2020. Surgery was performed in both eyes with an interval of approximately two weeks. The patients were interviewed six months after the second eye surgery . All surgeries were performed by four surgeons, and all IOL calculations were performed using *IOLMaster*. Written informed consent was obtained from all patients after the objectives and protocols of the study were explained. The study was conducted in accordance with the ethical principles specified in the Declaration of Helsinki and was approved by the Institutional Review Board of KFHU.

2.1. Inclusion and Exclusion Criteria

2.1.1. Inclusion Criteria

Patients who sought post-operative spectacle independence after cataract surgery or refractive lens exchange.

2.1.2. Exclusion Criteria

Past medical and surgical histories were reviewed along with ancillary tests. Patients with previous ocular pathologies, such as glaucoma, macular degeneration and severe dry eye in whom vision-related QOL might be affected, or patients with past ocular surgeries, such as LASIK or photorefractive keratectomy, were excluded from the study. Optical coherence tomography of the macula and corneal tomography were ensured to be structurally normal and fit for non-toric trifocal IOL (corneal astigmatism <1.5 diopters, chord mu <0.5, irregular astigmatism (Root mean square) <0.3). Any patient who did not have one or both imaging modalities for any reason, at the time of the study, was repeated to ensure that all criteria had been applied. Patients with intraoperative or postoperative complications were excluded from the study.

Six months after the second eye surgery, all patients were interviewed and a complete ophthalmologic examination was conducted. They were given a questionnaire on the subjective quality of vision for daily visual activities, photic phenomena, spectacle independence and their visual satisfaction. Based on IOL model implanted, they were divided into two groups. A total of 39 patients participated in the study. All the patients received non-toric trifocal IOLs.

2.2. Study Parameters

The study parameters noted were preoperative uncorrected distance visual acuity and history of spectacle use. At the postoperative visit, the patients were examined for the following: binocular and monocular uncorrected distance visual acuity (UDVA) at 6 meters (m), uncorrected intermediate visual acuity (UIVA) at 60 and 80 centimeters (cm), and uncorrected near visual acuity (UNVA) at 40 cm. Other parameters included the incidence of posterior capsular opacification (PCO) in both eyes and with a questionnaire assessing the quality of life and visual function.

2.3. Postoperative Examination

Six months after the second eye procedure, binocular and monocular values of UDVA, UIVA, and UNVA (in decimal) were examined using Snellen's chart and recorded along with a slit-lamp examination of the anterior and posterior segments. The visual acuity was then converted into LogMAR for ease of comparison with previous studies. In addition, the incidence of posterior capsular opacification and power of the implanted IOL implanted were recorded. Quality of life and visual function were assessed using a questionnaire administered face-to-face that included photic phenomena such as the presence of dysphotopsia (halos and glare), difficulty in recognizing colours and double vision. The frequency of the photic phenomena ranged from 0 (never) to 4 (always). In addition, the patients were asked whether the photic phenomenon was bothersome. The questionnaire assessed nine visual activities at different distances, far, intermediate and near. The far activities included driving at night or during the day and watching TV. Seeing steps or climbing stairs, doing fine household work, and using a computer were considered intermediate activities, while the near activities included reading a newspaper, reading numbers using a telephone, and recognizing people when they were close. These were evaluated on a scale ranging from very bad to very good. Patients were also queried upon their spectacle independence at far, intermediate or near distances. In addition, the degree of satisfaction (very satisfied, fairly satisfied, fairly dissatisfied and very dissatisfied) about their vision, if they would recommend the same IOL to others and if they would choose it again for themselves.

2.4. Intraocular Lenses

Table **1** highlights the optical and physical properties of both the trifocal IOLs.

Table 1. Properties of the Acrysof IQ Panoptix and AT LISA Tri 839MP IOLs.

Property	Acrysof IQ Panoptix	AT LISA Tri 839MP
Optical Design	Diffractive-refractive Hybrid	Diffractive
Optic type	Nonapodized	Nonapodized
Technology	Trifocal	Trifocal
Optic material	Hydrophobic acrylate/ methacrylate copolymer	12% Hydrophilic acrylate with hydrophobic surface
IOL size	13.0 mm	11.0 mm
Optic size (diameter)	6.00 mm	6.00 mm
Diffractive region	4.5 mm	4.3 mm trifocal/4.3 to 6.0 mm bifocal
Central zone	Diffractive	Diffractive
Range (D)	6.0 to +34.0	0.0 to +32.0
Refractive Index	1.55	1.46
Near addition power (D)	+3.25	+3.33
Intermediate add power (D)	+2.17	+1.66
Active orders	0th, 2nd & 3rd	0th, 1st & 2nd
Asphericity (micrometers)	-0.10	-0.18
Lens color	Yellow	Clear

Abbreviations: D = Diopter

2.5. Statistical Analysis

All Continuous data were presented as mean with standard deviation, median and range used for data that were not normally distributed. Significance was tested using the t-test and ANOVA for normally distributed variables, and the Mann-Whitney U test and Kruskal Wallis test were used for abnormal data. Chi-square and Fisher exact test were used to test the significance of categorical data. All analyses were performed by using SPSS version 23.0, and a value less than 0.05 was considered significant($p<0.05$).

3. RESULTS

The demographic characteristics of 39 patients (78 eyes) included in this study are shown in (Table **2**). The age of 23 patients with the *AT LISA tri 839MP* IOL implant ranged from 41 years to 68 years, with a mean of 55.65 and a standard deviation (SD) of (7.1) while 16 patients with the *PanOptix* IOL showed a mean age and SD of 52.69 and 6.8 respectively, ranging from 41 years to 63 years. In both groups, the number of women was higher than that of men, reaching 60% in the *AT LISA* IOL group and 62.5% in the *PanOptix* group. The reason for lens surgery was a cataract in 100% of the patients in both groups. In addition, in both groups, the option of the trifocal lenses was suggested mostly by the surgeons; 65.2% for the former and 68.7% for the latter. There were no significant associations between any of the demographic variables (mean age, gander, choice of IOL by the surgeon) and the lenses used (p-value = 0.20, 0.87, 0.74, respectively).

Table 2. Demographical data and choice of IOL.

-	AT LISA (n=23)	PanOptix (n=16)	P-value
Age (in years) Mean (Standard deviation) Minimum – Maximum	55.65 (7.1) 41-68	52.69 (6.8) 41-63	0.200
Gender Male (%) Female (%)	9 (39.1%) 14 (60.1%)	6 (37.5%) 10 (62.5%)	0.862
The choice of Trifocal IOL by Patient Surgeon	8 (34.8%) 15 (65.2%)	5 (31.3%) 11 (68.7%)	0.745

All patients underwent a pre-operative (UDVA) examination and the results were recorded (Table **3**). In the *AT LISA tri 839MP* IOL group, the median left and right UDVA were 0.6 and 0.5, respectively (range 0.1-0.8), while in the *PanOptix* group, they were almost equal at 0.55 and 0.50, respectively. The majority of the patients had no history of spectacle use before the surgery (60.9% in the *AT LISA* group and 62.5% in the *PanOptix* group). The median power of the implanted IOL was 21.5 D in the first group, with a range from 15-26 D, while in the second, the median power was 21 D, with a range from 16 to 24 D. None of the pre-operative values (left UDVA, right UDVA and glasses use) showed any significant associations with the lens type (p-values= 0.90, 0.79, 0.59 respectively).

Table 3. Preoperative uncorrected distance visual acuity, history of glass uses, and IOL power.

-	AT LISA (n=23)	PanOptix (n=16)	P-value
Pre-operative left UDVA Median (Range) in decimal	0.60 (0.1 – 0.8)	0.55 (0.1 – 0.8)	0.899
Pre-operative right UDVA Median (Range) in decimal	0.50 (0.1 – 0.8)	0.50 (0.1 – 0.8)	0.789
History of glasses use before surgery Yes (%) No (%)	9 (39.1%) 14 (60.9%)	6 (37.5%) 10 (62.5%)	0.593
IOL power implanted Median (Range)	21.5 D (15-26)	21.0 D(16-24)	0.359

Abbreviations: UDVA = uncorrected distant visual acuity, D = diopters

Postoperatively, the range of binocular UNVA and UIVA in both groups and the range of binocular UDVA at 6 m in the panOtix group, were 0.10 to 0.00 LogMAR. However, binocular UDVA was 0.40 to 0.00 LogMAR in the *AT LISA* IOL group. The median binocular UNVA and UDVA were the same in both the IOL groups at 0.00 LogMAR. The median UIVA at 60 cm was lower in the *AT LISA* group at 0.10 LogMAR when compared to 0.00 LogMAR of the *PanOptix* group. However, the median binocular UIVA at 80 cm was higher in the *AT LISA* group at 0.00 LogMAR when compared to the *PanOptix* group (0.10 LogMAR). The same values were

obtained for the monocular examination on the right side. For the left side, the range of UNVA and UIVA was 0.20 – 0.00 LogMAR, and the range for UDVA was 0.4 - 0.00 LogMAR in the *AT LISA*. The range in *PanOptix* in all distances remained the same at 0.10 – 0.00 LogMAR. The median values were 0.00 LogMAR for all categories except for UIVA at 60 cm in the AT LISA group (0.10 LogMAR) and UIVA at 80 cm in the PanOptix group (0.10 LogMAR). Neither group of IOLs had any significant associations with the UNVA, UIVA or UDVA values (Table **4**).

Postoperative ophthalmic examination for the incidence of PCO (Table **5**) yielded results that indicated its absence in most of the patients of the *AT LISA* (Left:91.3% Right: 86.9%) or the *PanOptix* (Left: 93.7%, Right: 100%) group. There was no significant association between type and PCO formation.

Through the questionnaire, photic phenomena, namely, glare and halos, difficulty in recognizing colours and double vision, were evaluated at the post-operative visit (Table **6**). Both lenses showed similar results. The majority of the patients (39.1% and 37.5%) reported an occasional glare for both IOLs (*AT LISA* and *PanOptix,* respectively), while a minority of the patients in both groups (4.3% and 12.5%, respectively) always had glare. For halos, the majority had an occasional occurrence (43.5%) in the *AT LISA* group, and many (34.8%) had it often, whereas a small number (8.7%) always experienced it. On the contrary, in the PanOptix group, the majority (37.5%) experienced halos often, and 31.3% had it occasionally. A notable 12.5% had it always. Neither symptom (glare and halos), however, had a significant correlation to the IOL type (p-value=0.8, 0.86, respectively). None of the patients had double vision using either lens. Three patients (two in *the AT LISA* and one in the *PanOptix* group) had difficulty in recognizing colour at the post-operative visit. These symptoms were found troublesome by less than 20% of the patients in either group (17.4% in *AT LISA* group and 18.8% in *PanOptix* group) with insignificant p-value (0.62).

Table 4. Preoperative uncorrected distance visual acuity, history of glass uses, and IOL power and range.

-	-	AT LISA (n=23) Decimal	AT LISA (n=23) LogMAR	PanOptix (n=16)	PanOptix (n=16) LogMAR	P-value
Median Postoperative Binocular VA (range)	UNVA at 4 cm	1.0(0.8-1.0)	0.00 (0.10-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.921
	UIVA at 60 cm	0.8(0.8-1.0)	0.10 (0.10-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.059
	UIVA at 80 cm	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.8(0.8-1.0)	0.10 (0.10-0.00)	0.050
	UDVA at 6 M	1.0(0.4-1.0)	0.00 (0.40-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.563
Median Postoperative Monocular VA for center eye (range)	UNVA at 40 cm	1.0(0.6-1.0)	0.00 (0.20-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.944
	UIVA at 60 cm	0.8(0.6-1.0)	0.10 (0.20-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.210
	UIVA at 80 cm	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.8(0.6-1.0)	0.10 (0.20-0.00)	0.147
	UDVA at 6 m	1.0(0.4-1.0)	0.00 (0.40-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	1.000
Median Postoperative Monocular VA for right eye (range)	UNVA at 40 cm	1.0(0.8-1.0)	0.00 (0.10-0.00)	1.0(1.0 -1.0)	0.00 (0.00-0.00)	0.746
	UIVA at 60 cm	0.8(0.8-1.0)	0.10 (0.10-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.136
	UIVA at 80 cm	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.8(0.6-1.0)	0.00 (0.20-0.00)	0.288
	UDVA at 6 m	1.0(0.4-1.0)	0.00 (0.40-0.00)	1.0(0.8-1.0)	0.00 (0.10-0.00)	0.569

Abbreviations: VA = visual acuity, UNVA = uncorrected near visual acuity, UIVA = uncorrected intermediate visual acuity, UDVA = uncorrected distant visual acuity

Table 5. Incidence of posterior capsule opacification (PCO).

Posterior capsule opacification	AT LISA N(%)(n=23)	PanOptix N(%)(n=16)
center eye Yes no	2(8.6%) 21(91.3%)	1(6.2%) 15(93.7%)
Right eye Yes no	3(13%) 19(86.9%)	0(0%) 16(100%)

Abbreviations: N = number, n = total number

Table 6. Frequency of dysphotopsia, Double vision, difficulty in recognizing color and whether symptoms are disturbing.

-	-	AT LISA N(%) (n=23)	PanOptix N(%)(n=16)	P value
Glare	Never	9(39.1)	5(31.3)	0.803
	Occasionally	9(39.1)	6(37.5)	
	Often	4(17.4)	3(18.8)	
	Always	1(4.3)	2(12.5)	

(Table 6) contd.....

Halos	Never	3(13.0)	3(18.8)	0.869
	Occasionally	10(43.5)	5(31.3)	
	Often	8(34.8)	6(37.5)	
	Always	2(8.7)	2(12.5)	
Double vision	Never	23(100)	16(100)	
Difficulty in recognizing color	Never	21(91.3)	15(93.8)	0.637
	Occasionally	2(8.7)	1(6.3)	
Are these symptoms disturbing	Yes	4(17.4)	3(18.8)	0.617

Abbreviations: N = number, n = total number

Table 7. Spectacle Independence and Patient Satisfaction.

-	-	AT LISA N(%) (n=23)	PanOptix N(%) (n=16)	P value
Do you use spectacle for distance or intermediate or near vision?	No	20(87.0)	15(93.8)	0.681
	Yes for distance	1(4.3)	1(6.3)	
	Yes for intermediate	1(4.3)	0	
	Yes for near vision	1(4.3)	0	
Are you now satisfied with your vision	Fairly dissatisfied	1(4.3)	0	0.699
	Fairly satisfied	4(17.4)	3(18.7)	
	Very satisfied	18(78.3)	13(81.3)	
would you recommend the same IOL to other and would choose it again	Yes	22(95.7)	16(100)	0.590

Abbreviations: N = number , n = total number

In both groups, most of the patients did not need spectacle correction post-operatively (*AT LISA*, 87%; *PanOptix*, 93.8%). Only one patient required spectacles for distant vision in the PanOptix group and three patients (one for distance, one for intermediate and one for near) in the *AT LISA* group. Most of the patients were very satisfied with both lenses (*AT LISA*, 78.3%; *PanOptix*, 81.3%). One patient was fairly dissatisfied in the *AT LISA* group. All patients who had *PanOptix* IOL, approved that they would choose this IOL again or recommend it to others, while with the *AT LISA*, around 4% showed disapproval. The patient who was fairly dissatisfied was asked about the reason, and he reported difficulty in vision and was scheduled for Yag capsulotomy for PCO (Table **7**).

The same questionnaire subjectively evaluated the quality of vision in nine daily visual activities performed at far, intermediate or near (Table **8**). The following items were included: driving (at night and during the day), watching TV, doing fine household work, using a computer, using or reading numbers in a telephone, climbing stairs, reading a newspaper and recognizing people when they are close. Most of the patients reported very good quality of vision in most visual activities. However, only 21.7% in the *AT LISA* group and 18.8% in the *PanOptix* groups reported very good quality of vision while driving at night. Moreover, it was the only visual activity reported as bad (*AT LISA,* 17.4%; *PanOptix,* 25%). *PanOptix* IOL showed higher subjective performance in intermediate vision when compared to *AT LISA,* such as using a computer and doing fine household work (62.5% and 30.4%), as well as seeing steps/climbing stairs (50% *vs* 39.1%). However, these values did not show any statistically significant associations with the type of lens used, similar to all other items.

Table 8. quality of vision in daily visual activities.

-	-	AT LISA N(%) (n = 23)	PanOptix N(%) (n = 16)	P value
Driving at night	Bad	4(17.4)	4(25.0)	0.843
	Good	14(60.9)	9(56.3)	
	Very good	5(21.7)	3(18.8)	
Driving day time	Good	11(47.8)	9(56.3)	0.802
	Very good	12(52.2)	7(43.8)	
Watching TV	Good	10(43.5)	7(43.8)	0.987
	Very good	13(56.5)	9(56.3)	
Doing Fine household work	Good	16(69.6)	6(37.5)	0.645
	Very good	7(30.4)	10(62.5)	

(Table 8) contd.....

Using a computer	Good	16(69.6)	6(37.5)	0.645
	Very good	7(30.4)	10(62.5)	
Using or reading numbers in telephone	Good	6(26.1)	4(25.0)	0.620
	Very good	17(73.9)	12(75.0)	
Seeing steps, climbing stairs	Good	14(60.9)	8(50.0)	0.501
	Very good	9(39.1)	8(50.0)	
Reading a newspaper	Good	11(47.8)	8(50.0)	0.894
	Very good	12(52.2)	8(50.0)	
Recognizing people when they are close to you	Good	5(21.7)	6(37.5)	0.282
	Very good	18(78.3)	10(62.5)	

Abbreviations N = number, n = total number

4. DISCUSSION

Two trifocal IOLs, *AcrySof PanOptix* and *AT LISA tri 839MP,* were compared in this study. Both IOLs provided similar favorable results for most parameters. The findings of UDVA, UIVA, UNVA, spectacle independence and quality of life related to vision were close to each other in both IOL groups, and similar to findings in previous studies with an identical postoperative follow-up period [11, 12, 17 - 20]. In addition, both trifocal IOLs compared in our study provided distance and near visual performance that is similar to that of bifocal IOLs, in addition to good intermediate vision [6, 10, 14, 21 - 23]. Overall, it can be determined that trifocal IOLs provide acceptable visual outcomes at all three distances, far, intermediate and near [23 - 25].

In a review article, the visual outcomes of different studies of *PanOptix* and *AT LISA* IOL showed good visual outcomes at all three distances. [16, 15] Previous studies found that while both lenses (*PanOptix* and *AT LISA*) provided excellent binocular (≤0.1 LogMAR) distance (97.1% and 100%) and comparable near vision (82.6% and 67%) respectively, *PanOptix* IOL provided better visual performance at 60 cm (75.4%) than *AT LISA* IOL (50%) [26, 27]. Despite a higher proportion (87% and 83%) of the patients in our study having excellent near vision (≤ 0.1 LogMAR), the other findings were actually similar in this study, as both IOLs gave ≤ 0.1 LogMAR visual acuity at a distance of 94% in the *PanOptix* group and in 87% in the *AT LISA* group. Additionally, intermediate vision testing depicted ≤ 0.1 LogMAR in 94% of patients with *PanOptix* IOL and 52% with *AT LISA* IOL at 60 cm. However, the reverse was true at 80 cm, as 63% of our patients with *Panoptix* IOL and 91% of the patients with *AT LISA* IOL group had visual acuity of ≤ 0.1 LogMAR. A recent study by Böhm *et al.* [28] included 80 patients with similar results to ours, where the visual outcomes at 60 cm (*PanOptix*) and at 80 cm (*AT LISA*) were ≤ 0.2 LogMAR. This signifies the importance of determining the preferred intermediate distance for each patient. In this study, a larger number of our patients in the *Panoptix* group showed better performance at intermediate activities than the AT LISA group, which included cooking (62.5% vs 30.4%) and using a computer (62.5% vs 30.4%). This might indicate that a distance of 60 cm for intermediate vision is preferred by a higher percentage of people. Although it did not show a statistically significant p-value (0.645) as our sample size was small, it could still be clinically significant. In addition, another study established similar findings regarding the intermediate vision outcomes in both lenses, concluding that the *PanOptix* IOL could be a better option in patients requiring closer intermediate viewing [29].

The quality of life of the patient was assessed subjectively, in the present study, using a questionnaire enquiring about the spectacle independence, perception of photic phenomena and the ease of performing visual activities. High spectacle independence was observed in previous studies reaching up to 95% for *PanOptix* and 93% for *AT LISA* IOLs [11, 14, 26, 30, 31]. In our study, comparable percentages showed a lack of spectacle correction requirements at any distance for both types of the IOLs (*PanOptix*, 93.8%; *AT LISA* 87%).

The perception of photic phenomena is expected to be high with multifocal IOLs, ranging between 15-95%. However, these phenomena decrease with time and are not considered bothersome by most patients [11, 14, 30, 31]. The present study reported a total photic phenomenon incidence of 87% in the *AT LISA* group and 82% in the *PanOptix* group. The incidence of glare (61.9% and 69.6%) and halos (87% and 81.2%) was similar for both IOLs, with insignificant p-values (0.80 and 0.86, respectively). However, only 17.4% of the *AT LISA* group and 18.8% of the *PanOptix* IOL group considered these symptoms significant or bothersome. Thus, most of the patients in both groups were satisfied (*AT LISA*, 95.7%; *PanOptix*, 100%), of which 78.3% in the former and 81.3% in the latter group were actually very satisfied. In a comparative study between these two IOLs, the photic phenomena were reported in 95% of the *PanOptix* group and 85% of the *AT LISA* group, which were mainly of halos [28]. These high percentages of reporting photic phenomena could be induced by the direct questioning about them, as in fact, more than 80% in each group confirmed that the symptoms were not disturbing in terms of their daily activities, with a comparably high level of satisfaction (100% and 95.7%; respectively). None of the groups had double vision in our study. This phenomenon was reported in a previous study using *PanOptix* IOL [16]. The lack of this occurrence in our study might be related to the small sample size.

Significantly fewer eyes developed PCO with *PanOptix* IOL (n=1 out of 16 (6.2%)) than with *AT LISA IOL* (n=4 out of 23, (17.4%)), which is consistent with the previous studies (*PanOptix*, 0.5%; *AT LISA*, 6-15%) [16]. However, the relatively high percentage of occurrence in the *PanOptix* IOL group in comparison to the previous studies is due to the small sample size. In addition, the low incidence rendered the p-value in our study inapplicable between the two groups. The

difference in the incidence of PCO between the two IOLs can be explained by the difference in hydrophilicity and edge design of the two IOLs. [28, 31].

5. LIMITATIONS

This study was limited by its small sample size, which does not allow the generalizability of the results. In addition, the follow-up period was short (6 months), and the efficacy of the lenses might be different if the period was longer. Another limitation is the lack of post-operative refraction, contrast sensitivity and objective measurements of the photopic phenomena. In addition, the difference in surgical techniques among the four surgeons might render our results variable.

CONCLUSION

Both trifocal IOLs showed similar favourable visual outcomes with a low frequency and severity of photic phenomena. Additionally, spectacle independence was high and comparable in both groups at all distances. Lower risk of PCO with the *PanOptix* IOL was noted when compared with the *AT LISA* lenses. The better performance of *PanOtptix* IOL in activities performed at intermediate distances is most likely the result of the different intermediate add power and, subsequently, the focal point. Hence, considering the patient's own preferred intermediate distance might be crucial prior to making a decision regarding the choice of trifocal IOL. However, further studies with a larger number of patients are recommended to confirm these outcomes.

LIST OF ABBREVIATIONS

IOL	=	Intraocular Lens
KFHU	=	King Fahad University Hospital
UDVA	=	Uncorrected Distance Visual Acuity
UIVA	=	Uncorrected Intermediate Visual Acuity
PCO	=	Posterior Capsular Opacification
LASIK	=	Laser-Assisted *in-Situ* Keratomileusis

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board of King Fahad University Hospital (KFHU), Eastern province, Khobar, Saudi Arabia

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of this study are available from the corresponding author [M.F], upon reasonable request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared None.

REFERENCES

[1] Villegas EA, Alcon E, Rubio E, Marín JM, Artal P. Refractive accuracy with light-adjustable intraocular lenses. J Cataract Refract Surg 2014; 40(7): 1075-84. [http://dx.doi.org/10.1016/j.jcrs.2013.10.046] [PMID: 24957429]

[2] Hütz WW, Eckhardt HB, Röhrig B, Grolmus R. Intermediate vision and reading speed with array, Tecnis, and ReSTOR intraocular lenses. J Refract Surg 2008; 24(3): 251-6. [http://dx.doi.org/10.3928/1081597X-20080301-06] [PMID: 18416259]

[3] Cochener B, Lafuma A, Khoshnood B, Courouve L, Berdeaux G. Comparison of outcomes with multifocal intraocular lenses: A meta-analysis. Clin Ophthalmol 2011; 5: 45-56. [PMID: 21311656]

[4] Zhong Y, Wang K, Yu X, Liu X, Yao K. Comparison of trifocal or hybrid multifocal-extended depth of focus intraocular lenses: A systematic review and meta-analysis. Sci Rep 2021; 11(1): 6699. [http://dx.doi.org/10.1038/s41598-021-86222-1] [PMID: 33758333]

[5] Xu Z, Li W, Wu L, Xue S, Chen X, Wu Q. Comparison of the clinical performance of refractive rotationally asymmetric multifocal IOLs with other types of IOLs: A meta-analysis. J Ophthalmol 2018; 2018: 4728258. [http://dx.doi.org/10.1155/2018/4728258] [PMID: 30363767]

[6] Alfonso JF, Fernández VL, Amhaz H, Montés-Micó R, Valcárcel B, Ferrer-Blasco T. Visual function after implantation of an aspheric bifocal intraocular lens. J Cataract Refract Surg 2009; 35(5): 885-92. [http://dx.doi.org/10.1016/j.jcrs.2009.01.014] [PMID: 19393889]

[7] Feng H, Qin H, Wang Z, Tian NN. Effect of different types of intraocular lens implantation on visual quality after cataract surgery. Int Eye Sci 2020; 12: 103-6.

[8] Alfonso JF, Fernández-Vega-Cueto L, Fernández-Vega L, Montés-Micó R. Visual Function after Implantation of a Presbyopia-Correcting Trifocal Intraocular Lens. Ophthalmic Res 2020; 63(2): 152-64. [http://dx.doi.org/10.1159/000500834] [PMID: 31390634]

[9] Hall CD, Barnes CS, Gutherie AH, Lynch MG. Visual function and mobility after multifocal *versus* monofocal intraocular lens implantation. Clin Exp Optom 2021; 105(1): 70-6. [PMID: 33730524]

[10] Alfonso JF, Fernández-Vega Cueto L, Belda-Salmerón L, Montés-Micó R, Fernández-Vega L. Visual function after implantation of a diffractive aspheric trifocal intraocular lens. Eur J Ophthalmol 2016; 26(5): 405-11. [http://dx.doi.org/10.5301/ejo.5000741] [PMID: 26797852]

[11] Kohnen T, Herzog M, Hemkeppler E, *et al.* Visual Performance of a Quadrifocal (Trifocal) intraocular lens following removal of the crystalline lens. Am J Ophthalmol 2017; 184: 52-62. [http://dx.doi.org/10.1016/j.ajo.2017.09.016] [PMID: 28923587]

[12] Alió JL, Plaza-Puche AB, Alió del Barrio JL, *et al.* Clinical outcomes with a diffractive trifocal intraocular lens. Eur J Ophthalmol 2018; 28(4): 419-24. [http://dx.doi.org/10.1177/1120672118762231] [PMID: 29619883]

[13] Cochener B, Boutillier G, Lamard M, Auberger-Zagnoli C. A comparative evaluation of a new generation of diffractive trifocal and extended depth of focus intraocular lenses. J Refract Surg 2018; 34(8): 507-14. [http://dx.doi.org/10.3928/1081597X-20180530-02] [PMID:

30089179]
[14] García-Pérez JL, Gros-Otero J, Sánchez-Ramos C, Blázquez V, Contreras I. Short term visual outcomes of a new trifocal intraocular lens. BMC Ophthalmol 2017; 17(1): 72. [http://dx.doi.org/10.1186/s12886-017-0462-y] [PMID: 28514944]
[15] Carson D, Xu Z, Alexander E, Choi M, Zhao Z, Hong X. Optical bench performance of 3 trifocal intraocular lenses. J Cataract Refract Surg 2016; 42(9): 1361-67. [http://dx.doi.org/10.1016/j.jcrs.2016.06.036]
[16] Sudhir RR, Dey A, Bhattacharrya S, Bahulayan A. Acrysof IQ panoptix intraocular lens *versus* extended depth of focus intraocular lens and trifocal intraocular lens: A clinical overview. Asia Pac J Ophthalmol (Phila) 2019; 8(4): 335-49. [http://dx.doi.org/10.1097/APO.0000000000000253] [PMID: 31403494]
[17] Lawless M, Hodge C, Reich J, *et al.* Visual and refractive outcomes following implantation of a new trifocal intraocular lens. Eye Vis 2017; 4(1): 10. [http://dx.doi.org/10.1186/s40662-017-0076-8] [PMID: 28396877]
[18] Mojzis P, Peña-García P, Liehneova I, Ziak P, Alió JL. Outcomes of a new diffractive trifocal intraocular lens. J Cataract Refract Surg 2014; 40(1): 60-9. [http://dx.doi.org/10.1016/j.jcrs.2013.06.025] [PMID: 24355721]
[19] Kretz FTA, Breyer D, Diakonis VF, *et al.* Clinical outcomes after binocular implantation of a new trifocal diffractive intraocular lens. J Ophthalmol 2015; 2015: 962891. [http://dx.doi.org/10.1155/2015/962891] [PMID: 26301104]
[20] Cochener B, Vryghem J, Rozot P, *et al.* Clinical outcomes with a trifocal intraocular lens: A multicenter study. J Refract Surg 2014; 30(11): 762-8. [http://dx.doi.org/10.3928/1081597X-20141021-08] [PMID: 25375849]
[21] Cillino G, Casuccio A, Pasti M, Bono V, Mencucci R, Cillino S. Working-age cataract patients: Visual results, reading performance, and quality of life with three diffractive multifocal intraocular lenses. Ophthalmology 2014; 121(1): 34-44. [http://dx.doi.org/10.1016/j.ophtha.2013.06.034] [PMID: 23953097]
[22] Jonker SMR, Bauer NJC, Makhotkina NY, Berendschot TTJM, Van Den Biggelaar FJHM, Nuijts RMMA. Comparison of a trifocal intraocular lens with a +3.0 D bifocal IOL: Results of a prospective randomized clinical trial Presented at the XXXI Congress of the European Society of Cataract and Refractive Surgeons, Amsterdam, the Netherlands, October 2013. J Cataract Refract Surg 2015; 41(8): 1631-40. [http://dx.doi.org/10.1016/j.jcrs.2015.08.011] [PMID: 26432120]
[23] Jonker SMR, Bauer NJC, Makhotkina NY, Berendschot TTJM. Erratum: Comparison of a trifocal intraocular lens with a +3.0 D bifocal IOL: Results of a prospective randomized clinical trial. J Cataract Refract Surg 2017; 43(1): 148-50. [http://dx.doi.org/10.1016/j.jcrs.2015.08.011]
[24] Jin S, Friedman DS, Cao K, *et al.* Comparison of postoperative visual performance between bifocal and trifocal intraocular Lens based on randomized controlled trails: A meta-analysis. BMC Ophthalmol 2019; 19(1): 78. [http://dx.doi.org/10.1186/s12886-019-1078-1] [PMID: 30871503]
[25] Xu Z, Cao D, Chen X, Wu S, Wang X, Wu Q. Comparison of clinical performance between trifocal and bifocal intraocular lenses: A meta-analysis. PLoS One 2017; 12(10): e0186522. [http://dx.doi.org/10.1371/journal.pone.0186522] [PMID: 29073156]
[26] Donmez O, Asena BS, Kaskaloglu M, Akova YA. Patients satisfaction and clinical outcomes of binocular implantation of a new trifocal intraocular lens. Int Ophthalmol 2020; 40(5): 1069-75. [http://dx.doi.org/10.1007/s10792-020-01390-9] [PMID: 32328922]
[27] Marques EF, Ferreira TB. Comparison of visual outcomes of 2 diffractive trifocal intraocular lenses. J Cataract Refract Surg 2015; 41(2): 354-63. [http://dx.doi.org/10.1016/j.jcrs.2014.05.048] [PMID: 25661129]
[28] Böhm M, Hemkeppler E, Herzog M, *et al.* Comparison of a panfocal and trifocal diffractive intraocular lens after femtosecond laser–assisted lens surgery. J Cataract Refract Surg 2018; 44(12): 1454-62. [http://dx.doi.org/10.1016/j.jcrs.2018.07.060] [PMID: 30392761]
[29] Asena BS. Visual and refractive outcomes, spectacle independence, and visual disturbances after cataract or refractive lens exchange surgery: Comparison of 2 trifocal intraocular lenses. J Cataract Refract Surg 2019; 45(11): 1539-46. [http://dx.doi.org/10.1016/j.jcrs.2019.06.005] [PMID: 31587938]
[30] Toto L, Falconio G, Vecchiarino L, *et al.* Visual performance and biocompatibility of 2 multifocal diffractive IOLs. J Cataract Refract Surg 2007; 33(8): 1419-25. [http://dx.doi.org/10.1016/j.jcrs.2007.05.010] [PMID: 17662435]
[31] Mendicute J, Kapp A, Lévy P, *et al.* Evaluation of visual outcomes and patient satisfaction after implantation of a diffractive trifocal intraocular lens. J Cataract Refract Surg 2016; 42(2): 203-10. [http://dx.doi.org/10.1016/j.jcrs.2015.11.037] [PMID: 27026443]