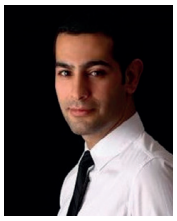
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Focusing on the Future: Patient-Centered Insights into Trifocal Intraocular Lens Adoption

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SUMMARY

Aims: To analyze determinants affecting the selection of trifocal intraocular lenses (IOLs) and to evaluate patient satisfaction and adaptation patterns post-implantation in a Turkish cohort.

Material and methods: A cross-sectional study was conducted using a 17-item questionnaire administered to 96 patients who underwent phacoemulsification with PanOptix trifocal IOL implantation. Demographics, IOL selection factors, surgeon trust, visual adaptation, and satisfaction metrics were analyzed across various patient subgroups.

Results*:* The cohort (mean age 60.62 ±11.94 years; 58.3% male) demonstrated 96.9% overall satisfaction post-implantation. Significant findings included higher satisfaction rates among patients under 65 years (98.3% vs 94.7%, p = 0.042), among tertiary-educated patients (98% vs 75%, p = 0.03), and 82.3% complete spectacle independence. Visual phenomena were reported at contemporary rates (glare: 18.8%, halos: 22.9%). Ninety-one percent of patients achieved visual adaptation within three months. Preoperative counseling participation (86.7% vs 71.4%, p = 0.035) and consistent follow-up attendance (88.9% vs 73.3%, p = 0.028) emerged as significant predictors of satisfaction.

Conclusion: Patient satisfaction with trifocal IOLs correlates significantly with age, educational background, and engagement in the treatment process. While overall satisfaction rates are high, outcomes appear influenced by demographic factors and healthcare engagement patterns. These findings emphasize the importance of comprehensive preoperative assessment, patient education, and tailored follow-up protocols in optimizing trifocal IOL outcomes across diverse population segments.

Key words*:* trifocal intraocular lenses, patient satisfaction, cataract surgery, spectacle independence, visual adaptation, patient selection, healthcare disparities

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INTRODUCTION

Cataract surgery with intraocular lens (IOL) implantation has made major strides over recent decades, progressing from being a sight-restoring procedure to an advanced refractive intervention designed for maximizing visual results and enhancing spectacle independence [1]. Introduction of the premium IOLs, particularly trifocal lenses, extends to overcome patients' increasingly spectacle independence in all visual situations [2,3]. Although the clinical effectiveness of trifocal IOLs is well-documented in the literature, there is a significant lack of research on patient perceptions and the factors influencing satisfaction with these advanced optical solutions [4].

Trifocal IOLs use advanced optical designs to split the light into distance, intermediate, and near – in most cases using diffractive or refractive IOLs' optic principles alone or a combination of both [5]. Clinical studies have shown its ability to provide functional vision at a wide range of distances. [6]. However, these quantitative data alone cannot fully capture patient experiences and satisfaction with trifocal IOLs.

Nonetheless, obstacles persist in the execution of trifocal IOL technology. Risk has previously been associated with photic phenomena (15–40% of patients), potential loss of contrast sensitivity, and problems related to careful patient selection, such as ocular comorbidities, pupil size, and corneal astigmatism [7]. This period

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of neuroadaptation to the new visual system may last several months and requires ongoing supervision both by patients themselves as well as by medical staff [8]. Furthermore, the large cost difference of these presbyopia-correcting IOLs requires a solid understanding of variables that affect patient satisfaction and outcomes [9].

While the clinical effectiveness of trifocal IOLs has been widely documented, gaps remain in understanding patient-reported outcomes, particularly regarding satisfaction and visual adaptation. Most existing studies originate from Western populations, leaving limited insights into their application in non-Western healthcare systems and diverse cultural contexts [10,11]. Socioeconomic factors, such as income levels and access to healthcare resources, can greatly influence patient adaptation to trifocal IOLs by affecting preoperative counseling quality and access to postoperative care [11,12]. Additionally, these factors may shape patient expectations and satisfaction, further emphasizing the need for context-specific research. Nevertheless, these aspects are often underexplored.

The current research seeks to fill these voids in knowledge by identifying factors in trifocal IOL preferences and evaluating the corresponding patient satisfaction in a Turkish cohort. By considering the factors that influence the adoption and improvement of premium IOLs, alongside the growing body of literature, our goal is to enhance clinical practice within this rapidly evolving field. This is especially relevant, given the current healthcare dynamics, where the use of premium IOLs is becoming more widespread, but conflicting cost limitations on their use, particularly in the light of increasing patient-reported outcomes, are being imposed [13,14].

We hypothesize that patient satisfaction with trifocal lenses would be further affected by particular social factors considered before surgery: functional expectations, lifestyle compatibility, work status, and the extent of quality counseling received. We aim to enhance patients' comprehension of trifocal IOL utilization.

MATERIAL AND METHODS

Study Design and Ethical Considerations

This cross-sectional study was designed to assess factors influencing trifocal IOL selection and patient satisfaction following implantation. The study protocol was reviewed and approved by the Clinical Research Ethics Committee of a university (Date: 26.05.2022, Decision No: 07). All procedures were conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki (2013 revision). Informed consent was obtained from all participants prior to their inclusion in the study.

The study included 96 patients, 56 males (58.3%) and 40 females (41.7%), aged 50–75 years, with a mean age of 60.62 ±11.94 years, who had previous phacoemulsification surgery with single type non-toric trifocal IOL (Alcon PanOptix) implantation, performed by a single surgeon (CÖ). Exclusion criteria included corneal and retinal pathologies, psychiatric disorders, diabetes mellitus, postoperative complications, and inability to comprehend or respond to the questionnaire.

Data Collection

Participants were given the option to complete a 17-item questionnaire in person during a follow-up visit. A trained research assistant was available to provide clarification if needed, without influencing responses.

The questionnaire collected demographic data, factors influencing IOL choice, trust in the surgeon, overall satisfaction, and specific aspects of visual function, including near, intermediate, and distance vision, glare, halo, night driving and daily activity ability [Supplementary 1]. Patient compliance with follow-up appointments was also recorded.

All statistical analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Kolmogorov-Smirnov test. A p-value < 0.05 was considered statistically significant for all analyses.

RESULTS

Table 1 provides an overview of participant characteristics and satisfaction rates across demographic subgroups.

Preoperative Characteristics

Prior to surgery, 55 patients (57.3%) required glasses for vision correction. Table 2 summarizes the factors influencing IOL choice and decision-making processes, highlighting the key role of surgeon trust (91.6%) and collaborative decision-making (92.7%).

Postoperative Satisfaction and Adaptation

Post-surgical outcomes showed that 93 patients (96.9%) reported overall satisfaction with their procedure, as illustrated in Table 1. Satisfaction rates were analyzed using Fisher's exact test, showing significant differences between demographic subgroups, except for gender, employment status and implantation type, which demonstrated no statistical significance ($p < 0.05$). Among all participants, 87 patients (90.6%) adapted to their new visual capabilities within three months of surgery.

Visual Function and Symptoms

The study assessed the visual demands of actively employed patients (n = 39), with Table 3 detailing the distribution of occupational visual distances. The majority utilized near and intermediate vision (64.1%). Table 4 outlines daily visual activities and the prevalence of visual symptoms linked to multifocal IOLs. Glare was reported by 18.8%, halos by 22.9%, difficulty with night driving by 15.6%, and reading small print by 9.4%.

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Table 1. Participant Characteristics and Satisfaction Rates by Demographic Subgroups

Demographic Factor	Subgroup	N (%)	Satisfaction Rate (%)	Statistical Significance
Age (mean ±SD)	< 65 years	58 (55.68%)	98.3	p = 0.042*
(60.62 ±11.94)	≥ 65 years	38 (44.32%)	94.7	
Gender	Male	56 (58.3%)	96.4	p = 0.72
	Female	40 (41.7%)	97.5	
Education	Tertiary	45 (46.9%)	98.0	p = 0.03*
	Primary/Secondary	51 (53.1%)	95.6	
Geographic Location	Urban	92 (95.8%)	97.8	p = 0.03*
	Rural	4 (4.2%)	75	
Employment Status	Actively Employed	39 (40.6%)	5.1	p = 0.29
	Not Actively Employed	57 (59.4%)	1.8	
Occupation Type for Employed	Computer-based	25 (64.1%)	96	p = 0.038*
	Manual tasks	14 (35.9%)	85.7	
Implantation Type	Bilateral	84 (87.5%)	97.6	p = 0.42
	Unilateral	12 (12.5%)	91.7	
Preoperative Counseling	Participated	89(92.7%)	86.7	p = 0.035 *
	Non-participated	7 (7.3%)	71.4	
Follow-up Compliance	Regular	81 (84.4%)	88.9	p = 0.028 *
	Irregular	15 (15.6%)	73.3	

**P-values < 0.05. All statistical comparisons were performed using Fisher's exact test.*

Table 2. Factors Related to IOL Choice and Decision-Making

		N (%)
Trust in Surgeon		88 (91.6%)
Collaborative Decision with Doctor		89 (92.7%)
Prior Knowledge of Premium IOLs		26 (27.2%)
Source of Information about IOLs	Doctor	12 (46.2%)
	Internet/social media	8 (30.8%)
	Friends/Family	6 (23.0%)

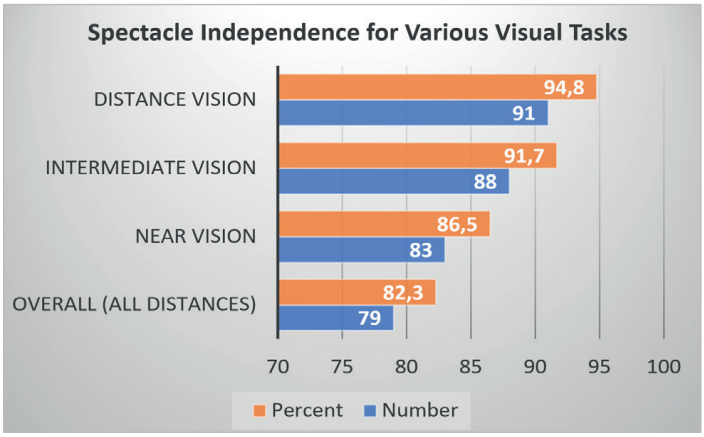
IOL – Intraocular lens

Table 3. Visual Distances Used by Actively Working Patients

Visual Distance	N (%)
Near and Intermediate	25 (64.1%)
Distance and Intermediate	11 (28.2%)
Near Only	2 (5.1%)
Distance Only	1 (2.6%)

Table 4. Visual Activities and Prevalence of Visual Symptoms

Activity/Symptom	N (%)
Computer Use > 2 hours/day	33 (34.4%)
Reading > 2 hours/day	29 (30.2%)
Glare	8 (18.8%)
Halos	22 (22.9%)
Difficulty with night driving	15 (15.6%)
Difficulty reading small print	9 (9.4%)



Graph 1. Spectacle Independence Rates Across Visual Distances Following Trifocal IOL Implantation

IOL – Intraocular lens

Implantation Patterns and Outcomes

Among the total cohort, 84 patients (87.5%) underwent bilateral trifocal IOL implantation, while 12 patients (12.5%) had unilateral implantation. Although the unilateral group exhibited lower satisfaction rates (91.7% vs. 97.6%) and overall spectacle independence (66.7% vs. 84.5%), and a higher incidence of visual symptoms (glare: 25.0% vs. 17.9%; halos: 33.3% vs. 21.4%), these differences were not statistically significant (p > 0.05 for all).

Spectacle Independence

Spectacle independence rates across various visual tasks are shown in Graph 1. The bar graph shows the percentage of patients (n = 96) achieving spectacle independence at different visual distances. Distance vision showed the highest rate of spectacle independence (94.8%, n = 91), followed by intermediate vision (91.7%, n = 88) and near vision (86.5%, n = 83). Overall

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complete spectacle independence across all distances was achieved in 82.3% (n = 79) of patients. These results demonstrate the effectiveness of trifocal IOLs in providing functional vision across the full range of distances

DISCUSSION

This study provides important insights into the factors influencing trifocal IOL selection and patient satisfaction in a Turkish population. The observed high overall satisfaction rate (96.9%) must be contextualized within contemporary trifocal IOL literature. Recent meta-analyses report satisfaction rates ranging from 85–93%, placing our results at the higher end of current benchmarks [7,15,16]. This exceptional satisfaction level appears to be closely linked to high surgeon trust (91.6%) and the collaborative decision-making process (92.7%), aligning with the study of Hawker et al. [17], emphasizing the importance of shared decision-making in premium IOL outcomes.

Demographic analysis revealed several significant correlations that advance our understanding of trifocal IOL outcomes. Age stratification demonstrated that patients under 65 years (n = 58) reported higher satisfaction rates (98.3%), compared to those over 65 (94.7%, p = 0.042). This age-related variation likely reflects multiple factors, including enhanced neuroplasticity facilitating adaptation, more demanding lifestyle requirements, and potentially better ocular health status. These findings support recent research highlighting the role of neural adaptation in multifocal IOL outcomes [2,8].

Educational background emerged as a significant determinant in both IOL selection and satisfaction outcomes. Patients with tertiary education (46.9%, n = 45) showed higher rates of active participation in decision-making (98%), compared to those with primary/secondary education (75%, n = 51, p = 0.03). This educational disparity suggests the need for tailored counseling approaches based on health literacy levels, supporting findings from recent Asian studies on patient education in premium IOL surgery [18,19].

Our cohort achieved 82.3% complete spectacle independence across all visual distances, aligning with the 73.3-96.7% range reported in Rosen et al.'s systematic review.[2] Preoperative counseling participation (86.7% vs 71.4%, p = 0.035) and consistent follow-up attendance (88.9% vs 73.3%, p = 0.028) emerged as statistically significant predictors of patient satisfaction outcomes. Occupational visual demands demonstrated particular significance among working patients (n = 39), with computer-based professionals reporting higher satisfaction with intermediate vision, compared to those performing manual tasks (96.0% vs 85.7%, p = 0.038). This occupation-specific variance in satisfaction rates substantiates the necessity of incorporating vocational visual requirements into IOL selection protocols [18,20,21].

Although our data suggested a difference in satisfaction rates between urban (97.8%) and rural (75.0%) patients, the very limited number of rural participants (n = 4) precludes any meaningful conclusions about geographic influences on outcomes, but this is also in keeping with the more general healthcare disparities noted by Chen et al. [22] Further studies with larger rural patient populations would be needed to properly investigate potential urban-rural disparities in trifocal IOL outcomes.

Satisfaction and visual symptoms after bilateral and unilateral trifocal IOL implantation were similar in our study, contrary to Bilbao-Calabuig et al. [23], who showed better results for patients with both eyes implanted. Our result could potentially be biased due to the relatively small number of unilateral cases (n = 12), which warrants further investigation in larger prospective studies.

Our findings regarding visual phenomena demonstrate the evolution of trifocal technology. The observed rates of photic phenomena (glare: 18.8%, halos: 22.9%) align with contemporary trifocal-specific studies rather than historical data, reflecting technological advancement in optical design [24–27]. This improvement can be attributed to enhanced diffractive optic designs, comprehensive preoperative counseling, refined patient selection criteria, and standardized adaptation protocols [28–30].

Integration of these findings into clinical practice suggests the necessity of a comprehensive approach to patient care. This should encompass standardized demographic assessment tools, risk stratification protocols, and occupation-specific visual demand analysis during the initial patient selection phase. Preoperative optimization should focus on tailored counseling and structured educational programs that address identified risk factors. The postoperative care strategy should incorporate demographic-specific follow-up protocols and targeted intervention programs for high-risk groups, with particular attention to remote monitoring solutions for rural patients.

Healthcare delivery enhancement requires a systematic approach to addressing identified disparities. The development of outreach programs for underserved areas, implementation of telemedicine support systems, and the creation of community-based vision rehabilitation networks represent essential steps toward optimizing outcomes across all demographic groups.

Several limitations of this study warrant consideration. Firstly, the cross-sectional design precludes evaluation of long-term adaptation processes. Secondly, the absence of detailed visual and refractive outcome data limits a correlation between objective clinical outcomes and patient satisfaction metrics. Moreover, the limited representation of rural patients constrains the generalizability of our geographic disparity findings.

Future research directions should prioritize longitudinal studies examining demographic-specific adaptation patterns, development of predictive models for patient satisfaction, investigation of socioeconomic influences on premium IOL outcomes, and assessment of telemedicine interventions in reducing geographic disparities. Such studies will be crucial in further refining our understanding of patient-specific factors in trifocal IOL

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outcomes and in optimizing care delivery across diverse populations.

CONCLUSION

The study emphasizes the importance of patient-focused care for trifocal IOLs, highlighting high satisfaction levels when patients are correctly selected, educated and supported. Differences in outcomes across urban and rural practices stress the need for interventions focusing on optimal care for all. Future studies should aim at uniform patient selection and care support strategies.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used, with caution, the QuillBot tool to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Supplementary 1

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IOL Selection Evaluation Survey

Participant No: .....

We aim to conduct an academic study to understand the factors influencing your premium intraocular lens selection after cataract surgery. This study will determine which intraocular lens is suitable for which patients and identify factors that physicians and patients should consider when selecting premium intraocular lenses. The information you provide will be kept strictly confidential and will only be used as data in our study.

Do you agree to participate in our survey? Yes .....No .....

1. What is your age? .....
2. What is your gender?
   A) Male
   B) Female
3. Where do you live?
   A) City center – district center
   B) Town – Village
4. What is your education level?
   A) Primary – secondary education graduate
   B) High school graduate
   C) University graduate
   D) Master's degree – doctorate graduate
5. Are you actively working?
   A) Yes, I continue my active work life
   B) No, I am not actively working (proceed to question 7)
6. Which viewing distance do you use most in your active work life?
   A) Only near distance
   B) Near and intermediate distance
   C) Far and intermediate distance
   D) Only far distance
7. Do you use a computer for more than 2 hours per day?
   A) Yes
   B) No
8. Do you spend more than 2 hours per day on near reading activities (books, newspapers, puzzles)?
   A) Yes
   B) No
9. Did you wear glasses before surgery?
   A) Yes
   B) No
10. Did you trust your doctor who would perform your cataract surgery?
    A) Yes, I completely trusted my doctor
    B) No, I sought a second opinion from another physician
11. How did you make the choice of lens type to be implanted in your eye during cataract surgery?
    A) I chose entirely based on my own opinion
    B) I decided together with my doctor
    C) I left it entirely to my doctor
12. Did you have knowledge about premium (smart) lens technologies?
    A) Yes
    B) No (proceed to question 14)
13. How did you obtain information about premium lens technologies? (Multiple options can be selected)
    A) Internet-social media
    B) From my doctor
    C) From relatives or friends
14. Do you experience difficulty with vision while driving at night after surgery?
    A) Yes
    B) No
15. Do you experience disturbing glare when looking at bright light sources (car headlights, street lights) after surgery?
    A) Yes
    B) No
16. Do you see circular light scattering (halos) around light sources at night after surgery?
    A) Yes
    B) No
17. Are you satisfied with the surgery performed on you overall?
    A) Yes
    B) No