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# Evaluation of multifocal intraocular lens suitability in cataract patients in a public hospital: in terms of ocular comorbidities

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## ABSTRACT

**Aims:** No data exist in the literature regarding suitability screening for multifocal intraocular lenses (MFIOLs), which are generally not covered by health insurance in public hospitals in Türkiye. This study aims to determine the proportion of patients unsuitable for MFIOL and to identify restrictive ocular comorbidities among patients undergoing cataract surgery at a tertiary public hospital.

**Methods:** This retrospective observational study included patients aged 40 years and older who underwent cataract surgery at a tertiary teaching hospital during an approximately 10-month period. Patients with a monofocal intraocular lens in one eye or those without indications for bilateral cataract surgery were excluded from the study. Before surgery, patients underwent comprehensive ophthalmological examinations, optical biometry measurements, and other necessary tests. Based on these assessments, ocular comorbidities were identified. The primary endpoint was to determine and analyze the proportions and characteristics of patients who were or were not suitable for MFIOL implantation, according to indications and contraindications defined in the current literature.

**Results:** Of the 1476 patients evaluated in the study, 721 (48.8%, mean age 71.5±8.7 years; 55.6% female) had undergone bilateral cataract surgery. Of these, 289 patients (40.1%) were found ineligible for MFIOL implantation based on predefined contraindications. The remaining 432 patients (59.9%) were found to be eligible for MFIOL. Of the 289 patients who met ineligibility criteria for MFIOL in one or both eyes, 6 (2.1%) had ocular surface and corneal disease, 13 (4.5%) had pupil abnormalities, 80 (27.7%) had retinal disease, 25 (8.7%) had glaucoma or optic neuropathy, and 118 (40.8%) had combined causes.

**Conclusions:** Ocular comorbidities were identified as restrictive factors for MFIOL in 40% of patients. It appears that if MFIOLs were covered by health insurance in public hospitals, approximately two-thirds of patients could benefit from MFIOLs.

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## Introduction

The most common practice in cataract surgery worldwide is phacoemulsification with implantation of monofocal intraocular lenses (IOLs) (1). The main reasons for this situation are the reliability of these lenses' long-term results and their cost-effectiveness in public hospitals, in line with state health policies (1). After monofocal IOL implantation, some patients may require glasses, most commonly for reading. Multifocal IOLs (MFIOL) reduce the patient's dependence on glasses after surgery (2,3). However, unlike monofocal lenses, not every cataract patient is a suitable candidate for an MFIOL because MFIOLs have certain disadvantages. The quality of vision and distance visual acuity may not be as good as with monofocal IOLs; this may decrease contrast sensitivity and cause photic phenomena such as glare, starbursts, and halos (4,5). These may affect the patient's daily activities and professional skills after surgery. Therefore, a healthy ocular surface and absence of optic nerve and macular pathology are important before surgery. In addition, the patient's personality characteristics, daily activities, professional work life, and expectations from the surgery must be taken into consideration. These features will provide an estimate of the extent to which the patient can tolerate potential adverse effects.

If preoperative diagnostic evaluations and patient selection criteria are not taken into consideration, additional surgical interventions such as replacement of an MFIOL with a monofocal IOL may be required. Although patients are suitable for MFIOL based on examinations and tests, they may not consent to MFIOL if informed about potential risks. In public hospitals with high patient populations, MFIOLs are not routinely used due to insufficient time for these detailed evaluations and associated additional costs. If these limitations are eliminated, the widespread use of MFIOL in public hospitals will provide better results for both patients and physicians. No data regarding MFIOL suitability screening in a public hospital in Türkiye were found in the literature. This study aims to determine the proportion of patients who are suitable or unsuitable for MFIOL implantation in a public hospital and to identify ocular comorbidities that render patients unsuitable.

## Methods

### Study design and participants

This retrospective observational study evaluated data from patients aged 40 and over who underwent cataract surgery at a tertiary teaching hospital between May 2024 and February 2025. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the University of Health Sciences Türkiye, Gülhane Scientific Research Ethics Committee (approval no: 2025-194, date: 08.04.2025). This study included all patients aged 40 and over who underwent cataract surgery between the specified dates and had comprehensive ophthalmological examinations and tests as part of preoperative preparation. Patients with incomplete examination data, those with a monofocal IOL in one eye, or those without an indication for bilateral cataract surgery were excluded from the study.

### Data collection

The data analyzed in this study were obtained from patient files and the electronic medical record system. Patients' systemic and ocular medical histories were evaluated. Each patient underwent a comprehensive eye examination, including visual acuity (uncorrected and best- corrected), slit-lamp biomicroscopy, dilated fundus examination, and applanation tonometry. These comprehensive examinations were performed by three experienced physicians (ACY, BAÇİ, and OA). The reliability of the data was ensured by all three physicians, who confirmed the examinations and diagnoses. Spectralis optical coherence tomography (OCT, Heidelberg Engineering, Heidelberg, Germany) of the macula and optic nerve was used to examine the patients, primarily for macular disease, vitreomacular interface diseases, and glaucoma. Visual field examination was performed with the Humphrey Field Analyzer (Humphrey Field Analyzer; Carl Zeiss Meditec, Inc., Dublin, CA, USA) in patients who required evaluation for glaucoma and optic neuropathies. Corneal topography with the Pentacam high resolution (Oculus Optikgeräte GmbH, Wetzlar, Germany) was performed on patients with a history of refractive surgery or suspected ectatic disease. The IOL Master 500 (Carl Zeiss Meditec AG, Germany) was used to obtain biometric measurements (keratometric values, corneal astigmatism, anterior chamber depth, and axial length) and to calculate IOL power. The following criteria were defined for severe dry eye: tear break-up time <10 seconds, tear meniscus height <0.1 mm, and Schirmer test score <5 mm. Keratometric measurements from corneal topography and corneal thickness measurements were evaluated for evidence of corneal ectasia and prior refractive surgery. Under normal lighting conditions, pupils with a diameter less than 2.5 mm were defined as small. Thinning of the nerve fiber layer and visual field defects consistent with pathology were used to diagnose optic nerve diseases. Corneal opacity, zonular weakness, diabetic retinopathy, strabismus, and other pathologies considered unsuitable for MFIOL were diagnosed based on clinical observation. A guideline study has been published that provides a comprehensive overview of best clinical practices for the selection and use of MFIOLs and sets out patient eligibility criteria for MFIOL (6). In accordance with this guideline, the contraindications for MFIOL implantation used to identify suitable and unsuitable groups in this study are summarized in Table 1.

| Table 1. Established contraindications for MFIOL implantation |
|---|
| Ocular surface disease (severe dry eye), corneal disease (opacity, ectasia, dystrophy, etc.) |
| History of refractive surgery, irregular astigmatism |
| Pupil issues (small pupil, ectopic pupil, iris coloboma, etc.) |
| Zonular issues (zonular weakness, pseudoexfoliation, trauma, etc.) |
| Impaired fundus visualization (due to advanced cataract, vitreous degeneration, or hemorrhage) |
| Retinal disease (diabetic retinopathy, retinal vascular occlusion, AMD, vitreomacular interface diseases, retinal dystrophies, etc.) |
| Optic nerve disease (glaucoma, optic neuropathies) |
| Strabismus/amblyopia |
| Combined |
| Other (uncertain biometric measurements, etc.) |
| MFIOL: Multifocal intraocular lens, AMD: Age-related macular degeneration |

### Statistical Analysis

IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY) was used for data analysis. Quantitative variables were defined as mean ± standard deviation, and qualitative variables as numbers and percentages (%). Normality of the continuous variables was assessed using the Kolmogorov-Smirnov test and Skewness and Kurtosis values. Based on these results, the data were considered normally distributed. To compare the characteristics of suitable and unsuitable candidates for MFIOL implantation, the chi-square test was applied to qualitative variables, and the t-test was applied to quantitative variables. A p-value of 0.05 or less was considered statistically significant.

## Results

### Demographic and clinical characteristics

The study evaluated 1476 patients who underwent cataract surgery during the study period. Seven hundred and fifty-five patients (51.2%) were excluded from the study because they had a monofocal IOL in one eye or lacked an indication for bilateral cataract surgery.

Data from 721 patients (48.8%) who underwent bilateral cataract surgery were analyzed. The mean age of these patients was 71.5±8.7 years (range 40-93 years, 55.6% female). Four hundred and thirty-two patients (59.9%) were evaluated as suitable candidates for bilateral implantation of MFIOLs. It was observed that patients who were suitable candidates for MFIOL were younger than those who were not suitable candidates (70.2±8.1 years vs. 72.1±8.9 years, p<0.001). Five hundred eighty-eight patients were ≥65 years of age. Only 277 (47.1%) of the patients in this age group were considered suitable candidates for MFIOL implantation. In contrast, 52 of 133 patients (39.0%) who were <65 years of age were considered good candidates for MFIOL implantation. No significant difference was observed between the suitable and unsuitable groups in terms of gender. Table 2 shows the demographic and clinical characteristics of candidates who were suitable for MFIOL and those who were not.

### Main outcomes

Two hundred and eighty-nine patients (40.1%) had contraindications to MFIOL implantation, as shown in Table 1. The flowchart showing the study population is presented in Figure 1. Of the 289 patients with ineligibility criteria for MFIOL in one or both eyes, 6 (2.1%) had ocular surface and corneal disease, 13 (4.5%) had pupil abnormalities, 80 (27.7%) had retinal disease, 25 (8.7%) had glaucoma or optic neuropathy, and 118 (40.8%) had combined causes. Of the six corneal diseases, two were due to corneal opacity, and one each was due to severe dry eye, keratoconus, and map-dot fingerprint dystrophy; the remaining one occurred in a corneal transplant patient. Of the 80 patients with retinal disease, 33 (41.2%) had age-related macular degeneration (AMD), 22 (27.5%) had diabetic retinopathy, 17 (21.2%) had vitreomacular interface disease, 4 (5.0%) had degenerative myopia, 3 (3.7%) had retinal vascular occlusion, and 1 had retinitis pigmentosa. The distribution of reasons for unsuitability for MFIOL implantation is shown in Table 3.

## Discussion

This study showed that 40.1% of patients who underwent bilateral cataract surgery at a tertiary state hospital over a period of approximately ten months had ocular comorbidities that prevented MFIOL implantation. Among ocular comorbidities, retinal diseases were the most frequent, accounting for 27.7%.

Of the patients who underwent bilateral cataract surgery, 59.9% were considered suitable for MFIOL implantation with respect to ocular comorbidities. While Halkiadakis et al. (7) reported this rate as 60.7% in their study evaluating 1200 patients, Deshpande et al. (8), who included 1691 patients, found this rate as 54.4%. The results showed that more than half of the patients were suitable for MFIOL. However, these ratios need to be interpreted carefully. This is because Halkiadakis et

**Table 2.** Demographic and clinical characteristics of suitable and unsuitable candidates for MFIOL implantation

| | Suitable candidates (n=432) | Unsuitable candidates (n=289) | p |
|---|---|---|---|
| **Age (years)** | | | |
| Mean | 70.2±8.1 | 72.1±8.9 | **<0.001** |
| Range of ages | 45 to 88 | 40 to 93 | |
| **Male, n (%)** | 110 (25.5) | 210 (72.7) | 0.015 |
| **Corneal astigmatism (D)** | | | |
| Mean corneal astigmatism | 0.57±0.24 | 1.20±0.86 | **<0.001** |
| Range of corneal astigmatism | 0.09 to 1.00 | 0.09 to 8.75 | |
| Mean K1 | 43.44±1.61 | 43.35±1.77 | 0.36 |
| Mean K2 | 44.01±1.64 | 44.54±1.87 | **<0.001** |
| **Anterior chamber depth (mm)** | 3.11±0.38 | 3.04±0.41 | 0.25 |
| **Axial length (mm)** | 23.47±0.94 | 23.41±1.12 | 0.34 |
| **IOL power (D)** | 21.08±2.21 | 20.98±2.82 | 0.46 |
| **Intraocular pressure (mmHg)** | 15.1±1.9 | 15.4±2.6 | 0.24 |

Data are presented as numbers and percentages, means, and standard deviations
Significant p-values are shown in bold
K1: Flat keratometry, K2: Steep keratometry, D: Diopter, IOL: Intraocular lens, MFIOL: Multifocal intraocular lens

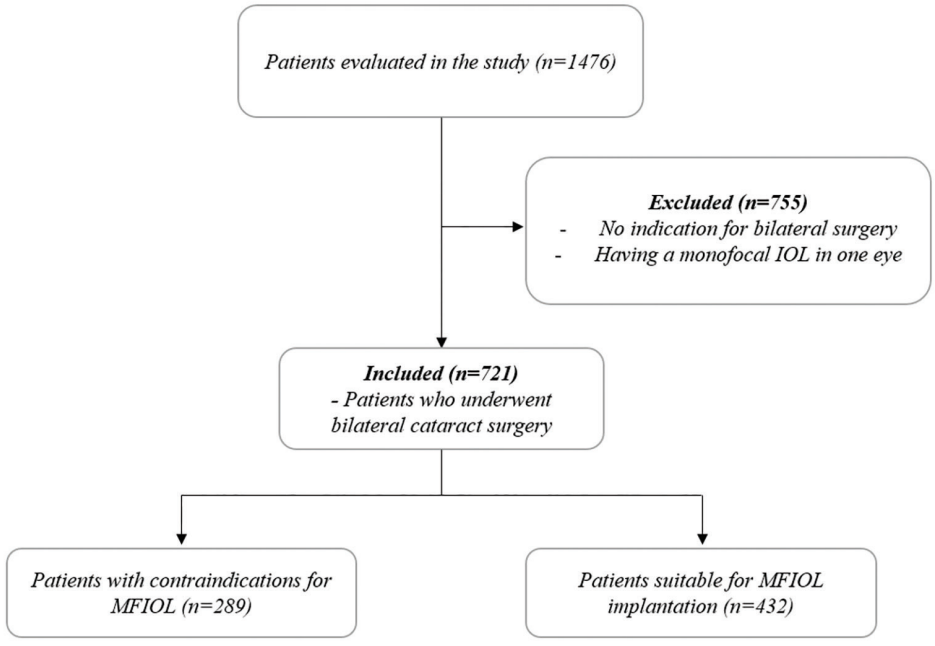



**Figure 1.** Flowchart showing the distribution of the study population
MFIOL: Multifocal intraocular lens, IOL: Intraocular lens

al. (7) used the same inclusion and exclusion criteria as in the present study. In addition, the mean age, which is closely related to ocular comorbidities, was quite similar to that of the present study (73.4±8). However, Deshpande et al. (8), when evaluating ineligibility for MFIOL, considered parameters such as angle kappa and personality traits, unlike the present study.

Ocular comorbidity is one of the main conditions that limit MFIOL implantation. According to the results of this study, 40% of the patients had an ocular disease in addition to cataract in one or both eyes. Pham et al. (9) reported an ocular comorbidity rate of 40% in 653 eyes that underwent cataract surgery, similar to this study. In the Auckland Cataract Study, this rate was found to be 26% in patients who underwent cataract surgery (10).

In the present study, the most common contraindication for MFIOL implantation was retinal pathology, which constituted the sole contraindication in 80 of 721 patients (11.1%). A comprehensive review of data collected by the Swedish National Cataract Registry, which includes data on more than 2.4 million cataract surgeries between 1992 and 2021, showed that more than 20% of patients had macular disease or diabetic retinopathy (11).

**Table 3. Distribution of reasons for not being suitable for MFIOL implantation**

| | n (%) |
|---|---|
| Ocular surface disease (severe dry eye), corneal disease (opacity, ectasia, dystrophy, etc.) | 6 (2.1) |
| History of refractive surgery, irregular astigmatism | 3 (1) |
| Pupil issues (small pupil, ectopic pupil, iris coloboma, etc.) | 13 (4.5) |
| Zonular issues (zonular weakness, pseudoexfoliation, trauma etc.) | 3 (1) |
| Impaired fundus visualization (due to advanced cataract, vitreous degeneration, or hemorrhage) | 30 (10.3) |
| Retinal disease (diabetic retinopathy, retinal vascular occlusion, AMD, vitreomacular interface diseases, retinal dystrophies etc.) | 80 (27.7) |
| Optic nerve disease (glaucoma, optic neuropathies) | 25 (8.7) |
| Strabismus/amblyopia | 1 (0.03) |
| Combined | 118 (40.8) |
| Other (uncertain biometric measurements, etc.) | 10 (3.4) |
| **Total** | **289** |

MFIOL: Multifocal intraocular lens, AMD: Age-related macular degeneration

In the current study, 41.2% of patients had AMD, 27.5% had diabetic retinopathy, and 21.2% had vitreomacular interface disease. Retinal pathology affects contrast sensitivity in these patients and makes fundus imaging difficult during vitreoretinal surgery (12,13). This situation can pose significant challenges for the surgeon due to the multiple images that may emerge.

Thirteen patients were not considered suitable candidates for MFIOL because of small pupils or an iris coloboma. Pupil size and shape are important in terms of potential dysphotopsia complaints (14). Pathologies such as iris colobomas and eccentric pupils may cause dysfunction of MFIOLs and therefore should be considered absolute contraindications (6).

In this study, one patient was not considered a suitable candidate for MFIOL because of a history of penetrating keratoplasty; two patients had corneal opacity, one had severe dry eye, one had keratoconus, one had map-dot-fingerprint dystrophy, and three patients had a history of refractive surgery. Keratoconus and forme fruste keratoconus are considered contraindications for MFIOL implantation because they are associated with coma (15,16).

Three patients were excluded as MFIOL candidates due to zonular weakness. The success of MFIOLs depends on proper implantation and centration. When the MFIOL is decentered or tilted, decreased contrast sensitivity, aberrations, and decreased visual acuity may occur (17). There are also different views that argue that mild zonular weakness is not a definite contraindication, regardless of etiology (6,18).

8.7% of patients were considered unsuitable candidates due to glaucoma or other optic neuropathies. Any optic nerve pathology that restricts visual acuity, contrast sensitivity, color perception, or field of view should be considered a contraindication to MFIOLs (6). Therefore, preoperative optic nerve evaluation with OCT and, if necessary, automated perimetry visual-field testing, may also identify patients with undiagnosed glaucoma. A significant proportion of patients in this study were unaware they had glaucoma. In some studies, the prevalence of undiagnosed glaucoma has been reported as high as 50% (19).

In this study, patients who did not have an indication for bilateral cataract surgery or who had previously undergone cataract surgery in one eye with implantation of a monofocal IOL were excluded. Some reduction in contrast sensitivity is expected with MFIOLs, and binocular implantation is advocated for improved visual quality and satisfaction (6). There are studies that argue that bilateral MFIOL implantation has a significant benefit in terms of improving binocular visual acuity, and that this effect is evident at all distances (20).

A key finding of the current study is that age is the main factor differentiating suitable from unsuitable candidates for MFIOL. This was, in fact, predictable as the frequency of comorbidities increases with age. These findings support the idea that younger patients achieve better visual gains after cataract surgery compared to older patients (21).

### Study Limitations

This study has some limitations. The study, being single-center and including patients with specific demographic and socioeconomic characteristics, may limit the generalizability of the results. We had no data on how many of the technically suitable candidates for MFIOL would consent to undergo implantation when the potential risks were explained. Due to its retrospective design, some parameters not routinely evaluated before cataract surgery but important for MFIOL suitability (such as corneal aberrations, pupil size, and angle kappa) were not analyzed. This situation may have led to an overestimation of the proportion of suitable candidates for MFIOL implantation. In a public hospital setting with a high patient volume, factors that may

make a patient an unsuitable candidate for MFIOL (personality traits, daily activities, expectations from surgery, etc.) were not evaluated. The strength of this study lies in reporting results from a large series of patients at a public hospital in Türkiye that performs a high volume of cataract surgeries.

## Conclusion

This study demonstrated the frequency of contraindications to MFIOL implantation due to ocular comorbidities in the Turkish population at a tertiary public hospital. This study also provides insight into the proportion of patients who could benefit from the inclusion of MFIOLs in health insurance coverage at public hospitals.

### Ethics

**Ethics Committee Approval:** The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the University of Health Sciences Türkiye, Gülhane Scientific Research Ethics Committee (approval no: 2025-194, date: 08.04.2025).

**Informed Consent:** Because the study was designed retrospectively no written informed consent form was obtained from the patients.

### Footnotes

### Author Contributions

Surgical and Medical Practices: A.C.Y., B.A.Ç.İ., O.A., F.M.M., Concept: A.C.Y., O.A., F.M.M., Design: A.C.Y., O.A., Data Collection or Processing: A.C.Y., B.A.Ç.İ., Analysis or Interpretation: A.C.Y., O.A., F.M.M., Literature Search: A.C.Y., B.A.Ç.İ., Writing: A.C.Y.

**Conflict of Interest:** The authors declare that they have no conflict of interest regarding this study.

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