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ORIGINAL RESEARCH REPORT

Overview of visual acuity improvement in postoperative cataract patients using a monofocal lens and phacoemulsification techniques

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ABSTRACT

Background: In Indonesia, one of the leading causes of blindness is cataract. Phacoemulsification is a surgical procedure that uses ultrasound energy to break the lens into pieces, which are then removed through by a probe. The lens is replaced with an intraocular lens (IOL) of the appropriate size for each patient. Monofocal lenses are among the most common lens types, which offer a single-focus correction for distance vision. However, additional glasses are required for near distances. **Objective:** to provide an overview of visual acuity improvement in postoperative cataract patients using monofocal lenses and phacoemulsification techniques. **Materials and Methods:** This study used an observational design and included postoperative cataract patients who underwent phacoemulsification with a monofocal lens at dr. Sjamsu Eye Clinic from September to November 2023. The data collected from the patients included their sex, age, operated eye, cataract type, and preoperative and postoperative visual acuity on days 1, 7, and 30. **Results:** A total 53 patients were evaluated. The majority of patients were female (57%) and between the ages of 60 and 69 years (43%). The preoperative visual acuity of the majority of patients was between <6/18 and <6/60 (60%). On day 30 post-surgery, the uncorrected visual acuity (UCVA) of 87% of patients was good, while the UCVA of the remaining patients was moderate. **Conclusion:** The visual acuity improvement in postoperative cataract patients using a monofocal lens and phacoemulsification techniques yielded satisfactory outcomes and met the standards for visual acuity by the World Health Organization (WHO).

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Highlights

1. The phacoemulsification techniques using a monofocal lens in postoperative cataract patients resulted in visual acuity improvement, which met the standards by the World Health Organization (WHO).
2. Postoperative cataract patients with a monofocal lens are required to wear additional glasses for near distances.

BACKGROUND

The eye is a vital sensory organ for human vision. Visual impairments can occur at any age and cause significant problems. In Indonesia, the prevalence of blindness among individuals over the age of 50 years ranged between 1.7% to 4.4%. The highest rate of blindness was observed in East Java at 4.4%, with over 80% of blindness cases being preventable. In Indonesia, one of the leading causes of blindness is cataract, accounting for 81.2% of cases. The prevalence of unoperated cataracts is 77.7%, with the main reasons for not undergoing surgery varying significantly in several provinces, including a lack of knowledge about cataracts and unawareness of their treatability (Purwati et al., 2016), as well as financial insufficiency and inaccessibility of medical services, which act as significant barriers to surgery in developing countries, including Indonesia (Jaggernath et al., 2013). The non-communicable disease (NCD) surveillance of regencies/cities in East Java Province in 2022 revealed that the highest prevalence of cataract cases was observed in Jombang City, with 29,025 cases documented and managed by community health centers, followed by Surabaya City with 11,205 cases (Wicitra et al., 2023). The number of cataract cases managed at dr. Sjamsu Eye Clinic in 2022 was 715 cases.

Cataract is a condition characterized by the opacification or clouding of the lens of the eye that can lead to progressive vision loss and, if the condition is left untreated, it may ultimately result in blindness (Lapp et al., 2023). The most effective treatment for vision loss due to cataracts is surgery (Tabin et al., 2008) or cataract extraction (Chang et al., 2008) in order to improve visual acuity and enhance the quality of life of patients (To et al., 2014). This medical treatment has been proven to be an effective intervention even in developing countries, with success rates ranging from 75% to 90% in terms of visual improvement, which is maintained for up to seven years (Chang et al., 2008). A variety of surgical techniques are available for the treatment of cataracts, including extracapsular cataract extraction (ECCE), intracapsular cataract extraction (ICCE), phacoemulsification, and small incision cataract surgery (SICS) (Gogate, 2010). However, the optimal approach varies considerably between individuals, depending on their medical history, ocular examination results, physical examination results, preoperative preparations, anesthesia requirements, and akinesia (Atkinson, 1958). One of the surgical techniques for the treatment of cataracts performed at dr. Sjamsu Eye Clinic is phacoemulsification. It has been claimed as a safe and effective medical treatment for cataracts. It has even become the gold standard for medical intervention for cataracts (Kumari et al., 2022). Unfortunately, it is costly (Jaggernath et al., 2013).

Phacoemulsification is a surgical procedure that uses ultrasound energy to remove the lens of the eye by breaking it into pieces, which are then suctioned out through a probe. Subsequently, an artificial intraocular lens (IOL) of an appropriate size is implanted. This technique is widely used due to its advantages, including small incisions, improved visual outcomes, shorter recovery times, and enhanced patient safety (Jain et al., 2019). IOLs are available in a variety of types that correct single and multiple focuses. The types of lenses include monofocal IOL, multifocal IOL, extended depth of focus (EDOF) IOL, accommodating IOL, and toric IOL (Kumari et al., 2020). One of the most commonly used lenses is the monofocal lens, which provides single focus correction for distance vision. However, additional glasses are required for near distances (Jain et al., 2019). The postoperative outcome aimed to improve visual acuity can be assessed using a Snellen chart (Courtney, 2020; Pajić et al., 2021) to enhance the quality of life of the patients.

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OBJECTIVE

This study aims to provide an overview of visual acuity improvement in postoperative cataract patients using a monofocal lens with phacoemulsification techniques.

MATERIAL AND METHODS

Study design

This study used an observational design with a cross-sectional approach. Medical records of postoperative cataract patients who underwent phacoemulsification using a monofocal lens at dr. Sjamsu Eye Clinic from September to November 2023 were collected and evaluated.

Data collection

The population in this study comprised all cataract patients who underwent cataract surgery using a monofocal lens and phacoemulsification techniques performed by an ophthalmologist. A total sampling technique was employed to ensure that the samples met the inclusion and exclusion criteria of this study. The inclusion criteria were all cataract patients aged 40 years or older. Meanwhile, the exclusion criteria were patients with complications (e.g., cataract uveitis), patients with a history of other eye diseases (e.g., glaucoma, retinal detachment, and macular degeneration), patients with uncontrolled systemic diseases (e.g., hypertension and diabetes mellitus), patients with a history of previous eye trauma or referral to another hospital, patients who did not attend regular follow-up appointments up to 30 days post-surgery, and patients with incomplete medical records.

The data collected from the patients included sex, age, operated eye, cataract type, as well as preoperative and postoperative visual acuity on days 1, 7, and 30 as measured using the Snellen chart, and operation reports. Uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA) data were recorded and categorized according to the criteria by the World Health Organization (WHO), namely good (6/6-6/18), moderate (<6/18-6/60), poor (<6/60-3/60), and blind (<3/60) (WHO, 2009). The data were processed using Microsoft Excel 2016 and are presented descriptively in tables and percentages.

Data analysis

The data on postoperative uncorrected visual acuity (UCVA) between day 1 and day 30 were compared statistically analyzed using the Friedman test, which is appropriate for categorical data and non-parametric statistics. The data were analyzed using Statistical Package for Social Scientists (SPSS) version 29.02.2. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 76 patients underwent phacoemulsification surgery performed by an ophthalmologist using a monofocal lens at dr. Sjamsu Eye Clinic from September to November 2023. However, only 53 patients were eligible for this study, comprising 23 (43%) male patients and 30 (57%) female patients between the ages of 43 and 84 years. Of the 53 patients, 29 (55%) underwent surgery on their right eyes, while 24 (45%) on their left eyes.

In terms of cataract stage, 51 (96%) eyes showed immature cataracts, while the remaining two (4%) eyes showed mature cataracts. At dr. Sjamsu Eye Clinic, immature cataracts were observed in 28 (53%) right eyes and 23 (43%) left eyes. In comparison, mature cataracts were observed in only one (2%) right eye and one (2%) left eye. Table 1 shows that before surgery, 32 (60%) eyes had moderate visual acuity, 11 (21%) eyes had poor visual acuity, and 10 (19%) eyes had blind visual acuity.

On the first day post-surgery, uncorrected visual acuity (UCVA) improved to the category of good visual acuity in 47 (89%) eyes and moderate visual acuity in six (11%) eyes. On the seventh day post-surgery, UCVA improved to the category of good visual acuity in 44 (83%) eyes, moderate visual acuity in eight (15%) eyes, and poor visual acuity in one (2%) eye. On the 30th day post-surgery, UCVA improved to the category of good visual acuity in 46 (87%) eyes and moderate visual acuity in seven (13%) eyes. The result indicated no significant difference between the results of postoperative UCVA on day 1 and day 30 ($p = 0.739$).

Table 1. Characteristics of patients undergoing cataract surgery (n = 53)

Characteristic	Frequency	%
Sex		
- Male	23	43%
- Female	30	57%
Age group		
- 40-49	3	6%
- 50-59	6	11%
- 60-69	23	43%
- 70-79	18	34%
- ≥80	3	6%
Operated eye		
- Right eye	29	55
- Left eye	24	45
Cataract stage		
- Mature	2	4
- Immature	51	96
Preoperative visual acuity		
- 6/6-6/18 (good)	0	0
- <6/18-6/60 (moderate)	32	60
- <6/60-3/60 (poor)	11	21
- <3/60 (blind)	10	19

Table 2. The results of postoperative uncorrected visual acuity (UCVA) on days 1, 7, and 30 post-surgery

Visual Acuity	Postoperative Uncorrected Visual Acuity (UCVA)					
	Day 1 (eyes)	Percentage (%)	Day 7 (eyes)	Percentage (%)	Day 30 (eyes)	Percentage (%)
6/6-6/18 (good)	47	89%	44	83%	46	87%
<6/18-6/60 (moderate)	6	11%	8	15%	7	13%
<6/60-3/60 (poor)	0	0%	1	2%	0	0%
<3/60 (blind)	0	0%	0	0%	0	0%
Total	53	100%	53	100%	53	100%

Table 3. Comparison of the results of best corrected visual acuity (BCVA) on day 30 post-surgery

Visual Acuity	Best Corrected Visual Acuity (BCVA)			
	Pre-Surgery (eyes)	Percentage (%)	Day 30 Post-Surgery (eyes)	Percentage (%)
6/6-6/18 (good)	0	0%	53	100%
<6/18-6/60 (moderate)	32	60%	0	0%
<6/60-3/60 (poor)	11	21%	0	0%
<3/60 (blind)	10	19%	0	0%
Total	53	100%	53	100%
p-value of day 1 to 30	0.739*			

*Kruskal-Wallis test

The findings revealed that on the 30th day post-surgery, best corrected visual acuity (BCVA) showed good corrected visual acuity. No eyes were categorized as moderate, poor, or blind based on the visual acuity examination.

DISCUSSION

This study revealed that the highest prevalence of cataracts was observed in female patients. This finding is consistent with a previous study (Chowdhury and Chakraborty, 2017), which reported that the highest prevalence of cataracts was observed in women due to exposure to cooking fuel smoke, poor kitchen ventilation, and estrogen hormonal factors. Extended exposure to smoke can result in an accumulation of oxidative stress on the eyes. In addition, reduced estrogen hormone levels during menopause can increase the risk of cataracts in women. The higher concentration of 17β-estradiol protects against oxidative damage induced by H_2O_2, which acts as an antioxidant on lens epithelial cells and protects the lens from cataractogenesis (Zetterberg and Celojevic, 2015).

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This study also revealed that patients between the ages of 60 and 69 years had the highest prevalence of cataracts. This finding is consistent with a previous study (Feriza, 2022), which found that patients between the ages of 60 and 69 years had the highest number of cases of cataracts. Another study found that patients between the ages of 60 and 79 years had the highest prevalence of cataracts (Sarkar et al., 2023). As humans age, their lenses undergo morphological, biochemical, and physical changes, leading to lens opacification (Sarkar et al., 2023). This process results in an increase in lens opacity and a decrease in elasticity. This condition occurs due to the continued production of epithelial fibers in the middle of the lens, causing it to become opaquer and less elastic. This ultimately leads to visual impairement (Hanis et al., 2023). This type of age-dependent cataract can be influenced by external factors, such as ultraviolet-B (UVB) exposure, type 2 diabetes mellitus, dehydration and severe diarrhea, as well as the use of steroids, nicotine and alcohol. The use of antioxidants can slow down the progression of the disease (Taylor, 1999).

The most frequently operated eye in this study was the right eye. Previous studies (Aswathappa et al., 2011; Birkett, 1987; Dane et al., 2003; McManus et al., 1999) indicated that individuals with right-hand dominance are more likely to develop cataracts in their right eye than those with left-hand dominance. This suggested a correlation between hand and eye preferences (Dane et al., 2007). In addition, the most common types of cataracts were immature and mature cataracts, which is consistent with a previous study (Feriza, 2022). This condition is related to the level of awareness and knowledge of individuals about cataracts (Guan et al., 2023). A study found that the incidence of cataracts in the right eye was due to nuclear cataract (19.4%), cortical cataract (17.4%), and posterior subscapular cataract (6.1%). All of these types of cataracts increased with age, with women having a higher incidence than men. This phenomenon has also been associated with an increase in cataract surgery (Klein et al., 2002).

The WHO standards for visual acuity are categorized into good (6/6-6/18), moderate (<6/18-6/60), and poor (<6/60) visual acuity (Pararajasegaram, 2002). This study found that all patients who underwent phacoemulsification showed a visual improvement one month after surgery. A study reported a visual improvement of 0.33 after surgery (95% CI: [0.31, 0.35]), with the predictor of ocular comorbidities such as diabetic retinopathy, glaucoma, and complication risk factors (i.e., high-risk surgery) (AlRyalat et al., 2022), age category (<40 years old), duration of operation (>60 minutes), or surgery without IOL (Sa'at et al., 2022). A study in Bali reported a visual acuity improvement with zero cases of blindness remaining. The patients had good vision, with 85.2% of them having normal to mild vision and minimal postoperative complications (Satwika et al., 2022). In this study, uncorrected visual acuity (UCVA) on the first day post-surgery showed good visual acuity, meeting the WHO standards. However, some patients showed moderate visual acuity, likely due to persisted inflammation and ongoing healing process.

On the seventh day post-surgery, an assessment of visual acuity was conducted, revealing changes over time. The changes were categorized as good, moderate, and poor visual acuity, which met the WHO standards. These finding are consistent with the findings of a study (Sihite, 2020), which reported a decrease in UCVA one week after surgery in the moderate and poor visual acuity groups. Corneal swelling was observed on the seventh day post-surgery and became stable two weeks later (De Juan et al., 2013). In addition, other studies observed a decline in visual acuity in the majority of operated patients (89.9%) with visual acuity of ≤ 20/200 and moderate cataracts. This decline could be attributed to an immunologic graft reaction and edematous cornea (Cung et al., 2019), as well as automated refraction and corneal swelling (De Juan et al., 2013).

On the thirtieth day post-surgery, another assessment of visual acuity was conducted, revealing that the majority of patients achieved good visual acuity, while a small proportion had moderate visual acuity. These findings are consistent with a study that reported a low prevalence of of moderate visual acuity (4.2%), while the majority had good visual acuity (Nurlan et al., 2022). Another study found that 3.4% of patients had poor visual acuity. However, all patients met the WHO standards, which could be due to Descemet's membrane folds still existing in the early postoperative period (Feriza, 2022), which is consistent with the findings of this study. It was also found that poor visual acuity was associated with preoperative ocular comorbidities (POC), with (OR = 3.28) (Khanna et al., 2020). Moreover, a study found a higher incidence of poor visual outcomes (34.6%) following phacoemulsification than

following manual small-incision cataract surgery (MSICS), which requires a smaller incision (Kumari et al., 2022). One of the factors affecting postoperative visual acuity is age (Sihite, 2020). In this study, both categories of good and moderate visual acuity met the WHO standards.

On the thirtieth day post-surgery, best corrected visual acuity (BCVA) met the WHO standards, as assessed using the Snellen chart, with 53 (100%) eyes achieving good visual acuity. This finding is consistent with the finding of a study (Hanis et al., 2023), which found that 96% of patients achieved BCVA. Another study also found that 94.9% of patients achieved BCVA, meeting the WHO standards for good visual acuity (Hanis et al., 2023). The findings are further supported by a study in India, indicating that postoperative cataract visual acuity was classified as good in 97.2% of cases (Paracha, 2011).

In this study, cataract surgery was performed using a monofocal IOL, a medical device that is implanted in the eye to restore distance vision (Fernández et al., 2023). This monofocal IOL had a single focal point, which enables clear vision for distance, but results in blurred vision for near objects due to the loss of accommodative ability (Ong et al., 2014). This condition necessitates the use of glasses for near vision, specifically reading glasses. Therefore, in this study, the patients required additional glasses with a power of +3.00 D for a reading distance of 30 cm (Richter-Mueksch et al., 2002). In a study with patients undergoing cataract surgery using monofocal IOLs on 493 unilateral eyes found that UCVA was influenced by refractive error condition (Khoramnia et al., 2022). Optimal results were achieved in the absence of refractive error (emmetropia). However, UCVA for both distance and near vision was not always optimally achieved in the study, necessitating the use of trifocal IOLs if near vision without additional glasses was desired. A six-month UCVA evaluation in a study comparing monofocal and multifocal IOLs revealed that 92% of patients with multifocal IOLs and 97% of patients with monofocal IOLs obtained a visual acuity of 20/40 or better. Therefore, the use of both monofocal and multifocal IOLs yielded good outcomes. The choice of an IOL depends on individual needs; multifocal IOLs offer better uncorrected visual acuity as they allow multiple distances to be seen without additional glasses, in contrast to monofocal IOLs. However, patients with multifocal IOLs have lower contrast sensitivity and a higher prevalence of photic phenomena, such as halos and glare, compared to those with monofocal IOLs (Shah et al., 2015).

Following cataract surgery, the eyes may feel uncomfortable and appear red for several days. Hood and Sugar (2015) mentioned several visual complaints following cataract surgery, including glare, halos, streaks, starbursts, shadows, and haze, which were tolerable (Hood and Sugar, 2015). These symptoms are attributed to the healing process and will subside, along with vision returning to normal within four to six weeks. Another study indicated that the recovery period following cataract surgery is relatively short, with the longest recovery time being four to 16 weeks. This is influenced by the natural recovery process, size of the cataract, and physiological differences between individual (Beyene et al., 2021). Postoperative visual acuity outcomes at different assessment times are influenced by systemic medical history, history of other eye diseases, operating surgeon, duration of surgery, biometric accuracy, and postoperative factors such as treatment and complications (Cox et al., 2019; Mohammed et al., 2023).

Limitations

The sample size was relatively small, with approximately 9.4% of cases lost to follow-up due to various reasons, including geographical factors, economic factors, or visual acuity-related improvements. This led to a decline in the number of patients returning for follow-up visits. Therefore, further studies involving large sample sizes over longer periods are necessary.

CONCLUSION

The visual acuity improvement in postoperative cataract patients using monofocal IOLs and phacoemulsification techniques has been demonstrated to yield satisfactory outcomes and meet the WHO standards for visual acuity. However, they require additional glasses for near vision.

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Conflict of Interest

The authors have no conflict of interest regarding the content of this study, authorship, and/or publication of this article.

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Ethical Clearance

This study received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Hang Tuah University, Surabaya, Indonesia with a certificate number I/011/UHT.KEPK.03/IV/2024.

Author Contribution

The authors contributed to all processes of this study, including preparation, data collection and analysis, as well as drafting the manuscript and approval for its publication.

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