ORIGINAL ARTICLE

# RELATIONSHIP BETWEEN INTRAOCULAR PRESSURE, DIABETES MELLITUS, AND HYPERTENSION WITH VISUAL ACUITY AFTER PHACOEMULSIFICATION SURGERY

**Reinne Natali Christine[1], Veronica Lusiana Sinurat[1], Tirsa Adella[2]**
*[1]Ophthalmology Department Christian University of Indonesia General Hospital, Jakarta*
*[2]Faculty of Medicine Christian University of Indonesia, Jakarta*
*Email: reinataline@gmail.com*

## ABSTRACT

***Introduction:*** *The objective of this study is to determine whether there is a relationship between intraocular pressure (IOP), diabetes mellitus, and hypertension with visual acuity in senile cataract patients after phacoemulsification surgery.*

***Methods:*** *A retrospective cross-sectional study of senile cataract patients who underwent phacoemulsification surgery from 2019-2020 at Christian University of Indonesia General Hospital. Data were taken from medical records using purposive sampling, consist of visual acuity before and after phacoemulsification, visual acuity during 3 months of follow up, IOP before and after phacoemulsification, and the presence of systemic comorbidities such as hypertension and diabetes mellitus. Data were analyzed statistically with SPSS.*

***Result:*** *122 eyes from 83 patients mostly had severe visual impairment before and a day after phacoemulsification, and improved to normal vision after a month and 3 months following phacoemulsification. The mean IOP was 18,36 mmHg and 21,33 mmHg before and after phacoemulsification. There were 78 patients who had systemic comorbidities such as hypertension and diabetes mellitus. There was no significant correlation between IOP and hypertension with visual acuity after phacoemulsification ($p>0,005$). Meanwhile, significant correlation was found between diabetes mellitus with visual acuity a day and a month after phacoemulsification ($p<0,005$).*

***Conclusion:*** *Diabetes mellitus has a significant relationship with visual acuity a day and a month after phacoemulsification surgery.*

***Keywords:*** *Intraocular pressure, diabetes mellitus, hypertension, visual acuity, phacoemulsification*

## INTRODUCTION

Cataract is the most common cause of blindness in the world. Indonesia is the 3rd country with the highest number of blindness in the world and is the first country in Southeast Asia with the rate of blindness due to cataracts which is 1.9%. According to the Rapid Assessment of Avoidable Blindness (RAAB) and the Ministry of Health of the Republic of Indonesia (2014-2016), the prevalence of blindness in Indonesia's population aged 50 years and over is 3.0%, which the main cause of blindness is unoperated cataract, which is 77.7%.[1,2]

Cataract is a clouding of the natural intraocular crystalline lens. It can cause blurred vision, glare, and may lead to eventual blindness if left untreated. Cataract often occur with age and may be a normal part of aging. However, poor nutrition, metabolic disorders such as

diabetes mellitus and hypertension, excessive exposure to sunlight or other sources of radiation, trauma, and certain medications can accelerate the development of cataracts.

There is no proven medical therapy to cure cataracts. Modern microsurgical techniques combined with intraocular lens implantation can restore normal vision in most cataract patients. The phacoemulsification technique is currently widely used because of faster visual acuity improvement, lower astigmatism changes, and low complication rates during surgery and postoperatively.[3]

One of the complications of cataract surgery is an increase in intraocular pressure (IOP). High IOP can cause transient corneal edema that will interfere with vision but will return to normal within a few weeks.[4,5] The authors conducted this study to determine whether there is a relationship between IOP, diabetes mellitus, and hypertension with visual acuity in senile cataract patients after phacoemulsification surgery.

## METHODS

This study is a retrospective cross-sectional study that was carried out by collecting secondary data from the medical records of senile cataract patients who had phacoemulsification surgery at the Christian University of Indonesia General Hospital from year 2019-2020. Patients who had no complication of phacoemulsification surgery and came for follow-up at least 3 months after surgery were included in this study. Patients with a history of ocular comorbidities such as infection, uveitis, glaucoma, and retinal abnormalities were excluded from this study.

The data collected including patient demographics, visual acuity before and after surgery, visual acuity during follow-up for 3 months, IOP before and after surgery, and systemic comorbidities the patients had such as hypertension and diabetes mellitus. The data obtained were then analyzed statistically using the Kruskal-Wallis and Chi-Square tests. The significance of the test results was determined based on the p value $< 0.05$. All analyzes were performed using the SPSS statistical program.

## RESULTS

There were 122 eyes from 83 patients who underwent phacoemulsification surgery who had routine check-ups 3 months after surgery. The characteristics of the patients could be seen in table 1. There were 42 female patients (50.6%) compared to 41 male patients (49.4%). The mean age of the patients was 66.39 years. There were 52 patients (62.7%) who had diabetes mellitus and hypertension.

**Table 1.** Characteristics of patients who underwent phacoemulsification surgery

| Characteristics | Total (%) |
|---|---|
| n = 83 patients | |
| **Gender** | |
| Man | 41 (49,4%) |
| Woman | 42 (50,6%) |
| **Average age (years)** | 66,39 |
| **Systemic comorbidities** | |
| Hypertension | 27 (32,5%) |
| Diabetes mellitus (DM) | 13 (15,7%) |
| Hypertension & DM | 12 (14,5%) |
| No comorbidities | 31 (37,3%) |

Table 2 showed that moderate visual impairment occurred at most preoperatively, which is 45 eyes (36.9%) followed by blindness as many as 33 eyes (27%). A day after phacoemulsification, moderate visual impairment remained in 45 eyes (36.9%), but blindness decreased to 10 eyes (8.2%). Improvement in visual acuity continued to increase during the 3 months of follow-up. There were 45 eyes (36.9%) with normal vision 1 month after surgery and increased to 60 eyes (49.2%) 3 months after surgery.

**Table 2.** Preoperative and postoperative visual acuity

| Visual acuity (ICD-11, 2021) | Preoperative n (%) | Postoperative day 1 n (%) | Postoperative month 1 n(%) | Postoperative month 3 n (%) |
|---|---|---|---|---|
| n = 122 eyes | | | | |
| **Blindness** | | | | |
| < 3/60 | 33 (27%) | 10 (8,2%) | 4 (3,3%) | 7 (5,7%) |
| **Severe visual impairment** | | | | |
| ≥ 3/60 - < 6/60 | 9 (7,4%) | 10 (8,2%) | 9 (7,4%) | 3 (2,5%) |
| **Moderate visual impairment** | | | | |
| ≥ 6/60 - < 6/18 | 45 (36,9%) | 45 (36,9%) | 40 (32,8%) | 25 (20,5) |
| **Early visual impairment** | | | | |
| ≥ 6/18 - < 6/12 | 21 (17,2%) | 26 (21,3%) | 24 (19,7%) | 27 (22,1%) |
| **Normal** | | | | |
| ≥ 6/12 | 14 (11,5%) | 31 (25,4%) | 45 (36,9%) | 60 (49,2%) |

ICD : International Classification of Diseases

In this study, most of the patients had normal preoperative and postoperative IOP which were 69.7% and 54.1%, respectively. Table 3 showed the average preoperative IOP was 18.36 mmHg, while the average IOP postoperatively was 21.33 mmHg (an increase of 16.21%).

**Table 3. Preoperative and postoperative intraocular pressure**

| | Preoperative IOP n (%) | Postoperative IOP day 1 n (%) |
|---|---|---|
| n = 122 eyes | | |
| **< 10 mmHg** | 0 | 0 |
| **10 - 20 mmHg** | 85 (69,7%) | 66 (54,1%) |
| **≥ 21 mmHg** | 37 (30,3%) | 56 (45,9%) |
| **Average IOP (mmHg)** | 18,36 | 21,33 |

IOP : Intraocular pressure

The relationship between IOP and systemic comorbidities with visual acuity after phacoemulsification could be seen in table 4. Based on the results of the Kruskal Wallis test, $p > 0.05$ was obtained in the relationship between preoperative and postoperative IOP with visual acuity after phacoemulsification. Based on the results of the Chi-Square test, $p > 0.05$ was obtained in the relationship between hypertension and both systemic comorbidities with visual acuity after phacoemulsification. $P < 0.05$ was obtained in the relationship between diabetes mellitus with visual acuity 1 day and 1 month after phacoemulsification, while 3 months after surgery, p value was > 0.05.

**Table 4. Relationship between IOP, hypertension, and diabetes mellitus with visual acuity after phacoemulsification**

| Variable | P value | | |
|---|---|---|---|
| | Postoperative visual acuity day 1 | Postoperative visual acuity month 1 | Postoperative visual acuity month 3 |
| **Intraocular pressure**[a] | | | |
| Preoperative | 0,75 | 0,728 | 0,692 |
| Postoperative day 1 | 0,642 | 0,895 | 0,892 |
| **Systemic comorbidities**[b] | | | |
| Hypertension | 0,969 | 0,879 | 0,960 |
| Diabetes mellitus (DM) | 0,045 | 0,030 | 0,084 |
| Hypertension & DM | 0,979 | 0,574 | 0,879 |

[a] Kruskal Wallis test
[b] Chi-Square test

## DISCUSSION

Senile cataract is defined as an incident of cataract at the age of 50 years and over. Aging creates biochemical changes in the lens that causes protein breakdown and aggregation, membrane cell fiber breakdown, glutathione deficiency, oxidative damage, an increase in calcium, abnormal migration of epithelial lens cells, reduced antioxidant activity, and water imbalance. These are some of the specific mechanisms that causes cloudiness of the lens.[6,7] In this study, the mean age of the patients was 66.29 years old.

Gender is a risk factor for senile cataract. In this study, no significant difference was found between the number of male patients (49.4%) and women (50.6%). Men's jobs that involve more exposure to ultraviolet light from the sun and women experience a decrease in estrogen levels after menopause, hence, the lens may fail to protect itself from oxidative stress mechanisms that have been linked to an increase of the risk of cataracts.[8]

Currently, phacoemulsification is the most common cataract extraction procedure in well-developed areas. In this procedure, an ultrasonically driven tip is used to emulsify the lens core and remove fragments using an automatic aspiration system. This method allows cataract surgery to be performed through smaller corneal incisions, resulting in a lower incidence of wound and vitreous-related complications and a quicker visual rehabilitation recovery.[9]

Prasad et al., Filho et al., and Li et al. explained that the phacoemulsification surgery technique has been shown to be effective in treating cataracts and improving vision compared to other surgical techniques.[10,11,12] Based on research by Gogate et al. and Pramita et al., improvement of vision with phacoemulsification will appear mainly around 6 weeks after phacoemulsification. This supports the results of the study because the time spam of when most patients achieve normal vision ($\geq$ 6/12) is about 1 to 3 months after surgery.[13,14] According to WHO, good postoperative vision results are when vision reaches the range of 6/18 – 6/6 so it can be said that the majority of patients achieved a good visual outcome at 3 months of control.[15]

Increased IOP 24 hours after surgery is a common occurrence. The increased IOP will return to normal after more than 24 hours. Increased IOP after phacoemulsification surgery can occur due to the usage of viscoelastic materials with high molecular weight. Viscoelastic materials that had remained in the lens capsule or anterior chamber could also clog the trabecular meshwork.[16,17] In this study, the mean IOP experienced a slight increase (± 16,21%) before and after phacoemulsification surgery.

Hypertension and diabetes mellitus are the most common systemic comorbidities found in senile cataract patients. Many studies have shown that hypertension is associated with the development of cataract due to the use of anti-hypertensive drugs. Cumming et al. reported a significant association between cataract risk and potassium-sparing diuretics, because these types of anti-hypertensive drugs can disrupt electrolyte balance across the lens fiber membrane. Several other studies have shown that exposure to beta-blockers can also increase cataract formation because it can increase intracellular levels of cyclic adenosine monophosphate, resulting in the modification of lens proteins.[18,19,20]

A study by Bautista et al. has found that elevated plasma levels of IL-6 and TNF-a occur in patients with hypertension, which is closely associated with an intense systemic

inflammation resulting in elevated levels of C-reactive protein, hence triggering cataract development. Hypertension has also been reported to cause a conformational change in the lens capsule, thereby interfering with potassium ion transport in the lens epithelial cells. The results of a study by Ornek et al. demonstrated that hypertensive patients would have significantly higher levels of nitrite in their cataract lenses; In which the resulting nitric oxide plays an important role in the pathogenesis of human cataract.[21]

Diabetes mellitus can affect the clarity of the lens as well as the refractive index and amplitude of lens accommodation. When the blood glucose level increases, the glucose content in the aqueous humor also increases. Unphosphorylated glucose enters the sorbitol pathway, which is another pathway for lens glucose metabolism. Aldose reductase is a key enzyme involved in the reduction of glucose to the sugar alcohol sorbitol, which is metabolized to fructose by sorbitol dehydrogenase. As the amount of glucose in the lens increases, relatively more of the sorbitol pathway is activated, causing sorbitol to accumulate. Poor lens permeability to sorbitol results in retention of sorbitol in the lens. In addition to sorbitol, increased fructose levels in the lens increase the osmotic pressure, making the lens attract more water. Initially, the lens energy-dependent pump is able to compensate, but eventually the pump becomes overwhelmed, resulting in fiber swelling, disruption of normal cytoskeletal architecture, and clouding of the lens.[9,20]

This study showed that there was no significant relationship between preoperative and postoperative IOP with postoperative phacoemulsification visual acuity ($p > 0.05$), which means that IOP is not a risk factor affecting postoperative phacoemulsification visual acuity. These results are in accordance with the studies done by Grzybowski et al. and Jadhav et al., where preoperative and 1-day postoperative IOP were also not associated with visual acuity at 1 month and 3 months after surgery.[16,21]

Systemic comorbidities included in this study were hypertension and diabetes mellitus. The results of the analysis showed that there was a significant relationship between diabetes mellitus and postoperative phacoemulsification visual acuity ($p < 0.05$), while hypertension did not have a significant relationship ($p > 0.05$).

In a study done by Fong et al., diabetics had slower visual acuity improvement rate than non-diabetic patients regardless of whether patients were currently suffering from diabetic retinopathy complications post-phacoemulsification during 12 months of control. A study by Shaikh et al. also showed similar results with 92% of non-diabetic patients achieving normal vision at 1 day post-operation and all diabetic patients taking 1 week to achieve normal vision. The results of this study showed that patients with a comorbid of diabetes mellitus had a

significant relationship to improvement in visual acuity after phacoemulsification, especially during 1 day and 1 month of control after phacoemulsification surgery. This can happen because diabetic patients undergoing cataract surgery are at risk of experiencing central macular thickening, causing macular edema. According to Kelkar et al., cataract surgery itself can affect the visual quality of diabetic patients because diabetic patients are more prone to keratoepitheliopathy, which includes defects or abrasions of the corneal epithelium that heal slowly.[22,23,24]

Cystoid macular edema (CMO) is a major cause of poor visual outcome and one of the most common complications of cataract surgery in both diabetic and non-diabetic patients. According to Liu et al., the pathogenic mechanism of macular edema is macular thickening due to postoperative inflammation caused by surgically damaged tissue, damage to the blood-retinal and blood-aqueous barriers, or the release of prostaglandins and vascular endothelial growth factors. Diabetes mellitus can cause structural and morphological changes in other parts of the eye including the cornea, tear film, lens, and retina that results in changes in the visual quality of the eyes of diabetic patients.[25,26]

The limitation of this study is the incomplete medical record data in the form of IOP 3 months after phacoemulsification surgery. For further research, it is possible to analyze the relationship between IOP for 3 months after surgery and post-phacoemulsification vision. In addition, an analysis of the relationship between IOP and the incidence of hypertension in patients can also be carried out for further research.

## CONCLUSION

Diabetes mellitus has a significant relationship with visual acuity a day and a month after phacoemulsification surgery.

### REFERENCES

1. Kementerian Kesehatan RI. Peta Jalan Penanggulangan Gangguan Penglihatan di Indonesia 2017-2030. Jakarta (ID): Kemenkes RI; 2018. p. 1-26.
2. Bourne RRA, Flaxman ST, Brithwaite T, Cicinelli MV, Das A, Jonas JB. Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis. Lancet Glob Health. 2017;5(9): e888-e897.
3. Anisimova SY, Anisimov SI, Novak IV, Avsineeva KM, Arutyunyan LL, Aldaraweesh MA. Effectiveness of femtosecond laser assistance in complicated cataracts. Vestn Oftalmol. 2016;132(1): 57-62.
4. Sani PU, Ikhsan M, Adriani. Perbedaan Tekanan Intraokular Pra dan Pasca Fakoemulsifikasi pada Pasien Katarak di Klinik Mata Kambang Jambi Tahun 2013. Fakultas Kedokteran dan Ilmu Kesehatan Universitas Jambi. 2013;1(1): 1-7.
5. Do JR, Oh JH, Chuck RS, Park CY. 2015. Transient corneal edema is a predictive factor for pseudophakic cystoid macular edema after uncomplicated cataract surgery. Korean J Ophthalmol. 2015; 29(1): 14–22.
6. Liu YC, Wilkins M, Kim T, Malyugin B, Mehta JS. Cataracts. Lancet. 2017;390(10094):600-12.
7. Khrisnawati AAAP, Adiputra KP, Kartiningsih IAP, Dwipayani NM, Prahesty HP. Characteristics of Cataract Patients in Wangaya Hospital Bali Year 2019: A Descriptive Study. EJMED. 2020;2(2): 1-3.

8. Manggala S, Jayanegara IWG, Putrawati AAM. Gambaran Karakteristik Penderita Katarak Senilis di Rumah Sakit Daerah Mangusada Badung Periode 2018. E-Jurnal Medika Udayana. 2021;10(7): 75-9.
9. (AAO BCSC 2020-2021 Lens & Cataract pg. 113)
10. Filho RS, Moreto R, Nakaghi RO, Haddad W, Coelho RP, Messias André. Costs and outcomes of phacoemulsification for cataracts performed by residents. Arq Bras Oftalmol. 2020;83(3): 209-14.
11. Li A, He Q, Wei L, Chen Y, He S, Zhang Q et al. Comparison of visual acuity between phacoemulsification and extracapsular cataract extraction: a systematic review and meta-analysis. Ann Palliat Med. 2022;11(2): 551-9.
12. Gogate PM, Kulkarni SR, Krishnaiah S, Deshpande RD, Joshi SA, Palimkar A et al. Safety and efficacy of phacoemulsification compared with manual small-incision cataract surgery by a randomized controlled clinical trial: six-week results. Ophthalmol. 2005;112(5): 869-74.
13. Hashmi FK, Khan QA, Chaudhry TA, Ahmad K. Visual Outcome of Cataract Surgery. J Coll Physicians Surg Pakistan. 2013;23(6):448-9.
14. Pramita RD, Sunariasih N. Visual Outcomes After Phacoemulsification in Sanjiwani Hospital Gianyar, Bali, Indonesia. Eur J Med and Health Sci. 2021;3(1):194-196.
15. Zia S, Iqbal Y, Ashraf KM, Mirza A. Intraocular Pressure after IOL Implantation with Hydroxypropylmethylcellulose 2% vs Hydro-implantation. Pak J Ophthalmol. 2013;19(1): 12-5.
16. Chan E, Mahroo OAR, Spalton DJ. Complications of cataract surgery. Clin Exp Optom. 2010;93(6): 379-89.
17. Ejimadu CS, Awoyesuku EA. Relationship between Intra Ocular Pressure and Visual Acuity in Port Harcourt, Nigeria. W J Opthalmol & Vision Res. 2019;2(1): 1-4.
18. Kanakamedala A, Go JA, Wendt S, Ugoh P, Khan M, Al-Mohtaseb Z. Systemic and Ocular Comorbidities of Black, Hispanic, and White Women with Cataracts. J Womens Health (Larchmt). 2022;31(1): 117-24.
19. Han SY, Chang Y, Shin H, Choi CY, Ryu S. Visual acuity and risk of overall, injury-related, and cardiovascular mortality: the Kangbuk Samsung Health Study. Eur J Prev Cardiol. 2021;22(zwab025): 1-9.
20. El-Sayyad HIH, Bakr EHM, El-Ghawet HA, El-Desoky TMGE. Overview of Congenital, Senile and Metabolic Cataract. J Ocular Biol. 2015;3(2):12.
21. Yu X, Lyu D, Dong X, He J. Hypertension and Risk of Cataract: A Meta-Analysis. PLoS ONE. 2014;9(12): e114012.
22. Shaikh AR, Mirani AH, Memon MS, Fahim MF. Visual outcome after phacoemulsification with lens implant indiabetic and non-diabetic patients; A comparative study. Pak J Med Sci. 2017;33(3): 691-94.
23. Ikegami Y, Takahashi M, Amino K. Evaluation of choroidal thickness, macular thickness, and aqueous flare after cataract surgery in patients with and without diabetes: a prospective randomized study. BMC Ophthalmol. 2020;20(102):1-7.
24. Kelkar A, Kelkar J, Mehta H, Amoaku W. Cataract surgery in diabetes mellitus A systematic review. Indian J Opthalmol. 2018 Oct;66(10):1401-10.
25. Liu J, Jones RE, Zhao J, Zhang J, Zhang F. Influence of Uncomplicated Phacoemulsification on Central Macular Thickness in Diabetic Patients: A Meta-Analysis. PLoS ONE. 2015;10(5): e0126343.
26. Chu CJ, Johnston RL, Buscombe C, Sallam AB, Mohamed Q, Yang YC. Risk Factors and Incidence of Macular Edema after Cataract Surgery: A Database Study of 81984 Eyes. Ophthalmol. 2015;123(2): P316-323.