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Analysis of Risk Factors for Increased Intraocular Pressure in Phacoemulsification Surgery: Single Center Study in Jakarta, Indonesia

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ABSTRACT

Background: Phacoemulsification, a common cataract surgery technique, can increase intraocular pressure (IOP) postoperatively. This study aimed to identify risk factors contributing to increased IOP, focusing on patient age and duration of phacoemulsification. **Methods:** A cross-sectional study was conducted at Harapan Jayakarta Hospital, Jakarta, for 4 months (May-September 2023) on 43 cataract patients ≥ 40 years old who underwent phacoemulsification. Inclusion criteria were preoperative IOP 10-21 mmHg, clear conjunctival and corneal structures. Data analysis was carried out univariate and bivariate using SPSS. **Results:** Analysis showed a significant correlation between patient age and phacoemulsification duration (older patients = longer phacoemulsification time), with a mean age of 63.21 years. Phacoemulsification duration >270 seconds significantly increases the risk of postoperative IOP. **Conclusion:** Prolonged exposure to ultrasonic waves during phacoemulsification can cause cellular injury to the internal structures of the eye, increasing IOP. Identifying modifiable risk factors, such as optimizing phacoemulsification timing, may reduce these complications and improve cataract surgery outcomes.

1. Introduction

A cataract is a clouding of the lens of the eye that can cause a gradual decrease in vision. A normal eye lens is clear and helps focus light on the retina, resulting in clear images. In cataracts, the lens becomes cloudy, and light cannot focus properly, causing blurred vision, glare, and double vision. Cataract surgery is the only way to cure cataracts. This procedure aims to remove the cataract lens and replace it with an artificial intraocular lens (IOL). Extracapsular cataract extraction (ECCE) is a traditional technique that involves a large incision in the cornea and the removal of the entire cataract lens capsule. Meanwhile, Phacoemulsification is a modern technique that uses ultrasonic waves to break the

cataract lens into small fragments, which are then sucked out. This technique has smaller incisions and a faster recovery than ECCE. Femtosecond Laser-Assisted Cataract Surgery (FLACS) is a newer technique that uses a femtosecond laser to create an incision and fragment the cataract lens. This technique offers greater precision and safety than traditional phacoemulsification.¹⁻³

Phacoemulsification is the most commonly used cataract surgery technique today because it has several advantages, such as smaller incisions, faster recovery, and lower risk of complications. However, like any medical procedure, phacoemulsification also has some risk factors that may affect its success. Older patients have a higher risk of complications. Patients

with diabetes, hypertension, and heart disease have a higher risk of complications. More severe cataracts require longer phacoemulsification times, increasing the risk of complications. Mistakes during surgery can cause complications, such as damage to the cornea or retina. Elevated intraocular pressure (IOP) is one of the most common complications following phacoemulsification surgery. High IOP can cause optic nerve damage and glaucoma, which can lead to permanent vision loss.⁴⁻⁶ This study aims to analyze the risk factors that contribute to increased IOP after phacoemulsification surgery at Harapan Jayakarta Hospital, Jakarta, Indonesia.

2. Methods

This study used a cross-sectional design. Data were collected at one point in time from patients who met inclusion criteria. This research was conducted at Harapan Jayakarta Hospital, Jakarta. This research was conducted for 4 months, from May to September 2023. The study population was all cataract patients ≥40 years old who underwent phacoemulsification at Harapan Jayakarta Hospital, Jakarta, during the research period. The research sample was taken by consecutive sampling. The inclusion criteria are Cataract patients ≥40 years old, undergoing phacoemulsification surgery, preoperative IOP 10-21 mmHg, and clear conjunctival and corneal structure. The exclusion criteria are patients with a history of previous eye surgery, patients with active eye disease, such as uveitis, glaucoma, and retinopathy, and patients using drugs that can affect IOP, such as steroids and antidepressants.

Data were collected through patient medical records to obtain information about age, gender, cataract diagnosis, duration of phacoemulsification time, and preoperative and postoperative IOP. Postoperative IOP examination, using a Goldmann tonometer. Data analysis was carried out univariate and bivariate using SPSS. Univariate analysis was carried out to determine the frequency distribution of the research variables. Bivariate analysis was carried out to determine the relationship between the variables age, gender, cataract diagnosis, duration of phacoemulsification time, and preoperative IOP with postoperative IOP. This study was approved by the ethics committee. All patients who met the inclusion criteria were asked to provide informed consent before participating in the study.

3. Results

Table 1 shows that this research involved 43 samples who met the inclusion criteria. Respondents were dominated by men, namely 29 people (67.4%). Meanwhile, 14 people (32.6%) were women. In terms of age, the average age of respondents was 63.21 years, with a standard deviation of 8.14 years. This shows that the majority of respondents are of advanced age. Based on the cataract stage, the majority of respondents (81.4%) had immature stage cataracts. Immature stage cataract is the initial stage of cataract where the lens of the eye begins to show cloudiness but does not significantly interfere with vision. Meanwhile, 8 respondents (18.6%) had mature stage cataracts, where the lens of the eye is very cloudy and significantly interferes with vision.

Table 1. Characteristics of respondents.

Characteristics	N (%)	Mean (SD)
Number of respondents	43 (100)	-
Age	-	63,21 (8,14)
Gender		
Male	29 (67,4)	-
Female	14 (32,6)	-
Cataract stage		
Immature	35 (81,4)	-
Mature	8 (18,6)	-

Based on Table 2, there is a significant positive correlation between age and duration of phacoemulsification (p-value < 0.001). This shows that the older the patient, the longer the duration of phacoemulsification required. This correlation is classified as moderate (r = 0.514). There was no significant correlation between age and increased IOP (p-value = 0.088). However, clinically, there is a positive correlation (r = 0.264) indicating that higher age can increase the risk of IOP. This correlation is

classified as weak. Although age did not significantly correlate with increased IOP, this does not mean that age has no effect on IOP. There was a significant positive correlation between the duration of phacoemulsification and the increase in IOP (p-value = 0.011). This shows that the longer the duration of phacoemulsification, the higher the risk of increasing IOP. This correlation is classified as moderate (r = 0.382).

Table 2. Correlation between variables.

Variable	Correlation with phacoemulsification duration	Correlation with IOP increase
Age	r = 0,514 (p-value < 0,001)	r = 0,264 (p-value = 0,088)
Phacoemulsification duration	-	r = 0,382 (p-value = 0,011)

Table 3 shows the differences in intraocular pressure (IOP) before and after phacoemulsification surgery in two age groups: under 57 years and over 57 years. This table provides information about how age may affect IOP changes after Phacoemulsification surgery. The age group under 57 years showed the mean pre-operative IOP in this age group was 15.0 mmHg. The mean postoperative IOP in this age group was 14.2 mmHg. The mean difference in IOP in this age group was -0.8 mmHg, indicating a decrease in IOP after phacoemulsification surgery. The age group

over 57 years shows the average pre-operative IOP in this age group is 16.5 mmHg. The mean postoperative IOP in this age group was 17.8 mmHg. The mean difference in IOP in this age group was 1.3 mmHg, indicating an increase in IOP after phacoemulsification surgery. The difference in IOP was greater in the age group over 57 years compared with the age group under 57 years. This suggests that older patients (over 57 years) are at greater risk of IOP elevation after phacoemulsification surgery.

Table 3. Differences in IOP before and after phacoemulsification surgery based on age.

Age group	Mean pre-operative IOP (mmHg)	Mean post-operative IOP (mmHg)	Mean IOP difference (mmHg)
Under 57 years old	15±1,11	14,2±1,22	-0,8±0,02
Over 57 years old	16,5±1,21	17,8±1,33	1,3±0,11

Table 4 shows the relationship between the duration of phacoemulsification and changes in intraocular pressure (IOP) after phacoemulsification surgery. This table provides information about how the duration of phacoemulsification may affect IOP changes after surgery. The phacoemulsification duration less than 270 Seconds group showed that the average IOP difference in this group was -0.5 mmHg,

which indicates a decrease in IOP after phacoemulsification surgery. The phacoemulsification duration of more than 270 seconds group showed the mean difference in IOP in this group was 1.2 mmHg, which indicates an increase in IOP after phacoemulsification surgery. The difference in IOP was greater in the phacoemulsification duration group of more than 270 seconds compared to the

phacoemulsification duration group of less than 270 seconds. This suggests that a longer duration of phacoemulsification (more than 270 seconds) is associated with an increase in IOP after

phacoemulsification surgery. In contrast, a shorter duration of phacoemulsification (less than 270 seconds) is associated with a decrease in IOP.

Table 4. Relationship between phacoemulsification duration and intraocular pressure.

Phacoemulsification duration (seconds)	Mean IOP difference (mmHg)
Less than 270	-0,5
More than 270	1,2

4. Discussion

The duration of phacoemulsification is one of the important factors that can influence the results of phacoemulsification surgery. Longer duration of phacoemulsification is associated with some risks. The heat generated during phacoemulsification can damage eye tissue and increase IOP. Trauma to the eye and inflammation may also occur due to the long duration of phacoemulsification, and this may increase IOP. Long phaco duration can cause damage to corneal endothelial cells, which can lead to corneal edema. Long phaco duration increases the risk of surgical complications, such as infection, retinal detachment, and posterior lens damage. More severe cataracts require longer phacoemulsification time to break down. More complex IOLs require longer phacoemulsification times to be inserted. More experienced doctors can usually complete phacoemulsification in less time. Newer, advanced phacoemulsification technologies may help shorten the duration of phacoemulsification. Doctors can take training and courses to improve their phacoemulsification skills.⁷⁻⁹

Newer and advanced phacoemulsification technologies may help shorten the duration of phacoemulsification. Simpler IOLs require shorter phacoemulsification times to be inserted. The harder lens in older patients requires longer phacoemulsification time to break down. The lens of the eye becomes harder and less elastic as we age. This makes it more difficult for the lens of the eye to break down by phacoemulsification. Older patients may have

comorbidities, such as diabetes, that can make the eye lens harder. Older patients may take longer to recover from phacoemulsification surgery. The body's healing ability decreases with age. This can make it take longer for older patients to recover from surgery. Older patients may have comorbidities, such as diabetes, that can slow the recovery process. Several previous studies have found an association between the duration of phacoemulsification and risk factors. One study found that a longer duration of phacoemulsification was associated with an increased risk of postoperative IOP. A study also found that older patients required longer phacoemulsification times compared with younger patients. A study also found that patients with diabetes required longer phacoemulsification times compared with patients without diabetes.¹⁰⁻¹²

Phacoemulsification surgery is an effective procedure for treating cataracts. However, like other operations, phacoemulsification carries a risk of complications, one of which is increased intraocular pressure (IOP). Elderly patients (over 57 years) have a higher risk of increased IOP after phacoemulsification surgery. Elderly patients are more likely to have comorbidities, such as diabetes, hypertension, and heart disease. These diseases can increase the risk of IOP. Elderly patients may use medications to treat comorbidities. Some types of medication, such as steroids and antidepressants, can increase IOP. As we age, physiological changes occur in the eye that can increase the risk of IOP. This can cause a buildup of aqueous humor and increase IOP. This may increase

the risk of trauma to the eye during phacoemulsification surgery, which may increase IOP.^{13,14}

Several previous studies have shown an association between age and increased IOP after phacoemulsification surgery. A study found that elderly patients (over 65 years) had a 2.5 times higher risk of experiencing an increase in IOP after phacoemulsification surgery compared with younger patients (under 45 years). A study also found that elderly patients with diabetes had a 3.2 times higher risk of increasing IOP after phacoemulsification surgery compared with younger patients without diabetes. Elderly patients have a higher risk of increased IOP after phacoemulsification surgery. Risk factors that can increase IOP in elderly patients include comorbidities, medication use, and physiological changes. Knowledge of these risk factors is important to assist physicians in identifying high-risk patients and taking preventive measures to reduce the risk of elevated IOP.^{15,16}

The duration of phacoemulsification is one of the important factors that can influence intraocular pressure (IOP) after surgery. Long duration of phacoemulsification (more than 270 seconds) was associated with increased IOP, whereas shorter duration of phacoemulsification (less than 270 seconds) was associated with decreased IOP. Increased IOP after long-duration phacoemulsification surgery can be caused by several mechanisms. Long duration of phacoemulsification can cause trauma to eye tissues, such as the cornea and iris. This trauma can cause cell damage and the release of inflammatory mediators, which can increase IOP. A long duration of phacoemulsification can cause eye inflammation. This inflammation can cause increased vascular permeability, which can lead to leakage of protein and water into the anterior chamber of the eye. This can increase IOP. Long duration of phacoemulsification can result in failure of aqueous humor drainage. Aqueous humor is the fluid that fills the anterior chamber of the eye and is responsible for maintaining intraocular pressure. Failed drainage of aqueous

humor can lead to increased IOP.^{17,18}

Several previous studies have shown an association between the duration of phacoemulsification and IOP. A study found that a longer duration of phacoemulsification was associated with increased IOP in patients undergoing cataract surgery. Another study found that a longer duration of phacoemulsification was an independent risk factor for increased IOP after cataract surgery. The duration of phacoemulsification is an important factor to consider in phacoemulsification surgery. Efforts to shorten the duration of phacoemulsification, such as the use of more efficient phacoemulsification techniques, may help reduce the risk of IOP elevation after surgery.¹⁶⁻¹⁹

5. Conclusion

This study suggests that prolonged exposure to ultrasonic waves during phacoemulsification can cause cellular injury to the internal structures of the eye, leading to increased IOP. Identifying modifiable risk factors, including optimizing the timing of phacoemulsification, has the potential to reduce the incidence of this complication, thereby improving surgical outcomes in cataract patients.

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