

Impact of Phacoemulsification Cataract Surgery to Number of Corneal Endothelial Cells: A Descriptive Study

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ABSTRACT

The main optical structure of the eyes is the lens and corneal because lens with the cornea, focuses image of the visual world onto the retina. Both of the main optical structure is affected by age, it affects the corneal endothelial cells and transparency of the lens. By aging the corneal endothelial cells decrease and the lens loses its transparency then the cataract appears [1,2]. It is known that cataract surgery effecting the corneal endothelial cells number. The surgery will be decreasing the corneal endothelial cells number. The severity to which endothelium is affected depends on many factors, such as phacoemulsification time and energy, surgical technique, anterior chamber depth, and use of ophthalmic viscoelastic devices (OVDs) [3]. A total of 52 people with cataracts were enrolled in this descriptive investigation. The study is included 52 eyes. Ages ranged from 43-77 years, with a mean age of 57,7 years. From this study 59,6% were men and the rest are women, which 79% were diagnosed with immature cataract, and 21% were diagnosed with mature cataract. It was found that 86,5% of eyes experienced a decrease in the number of corneal endothelial cells after cataract phacoemulsification surgery. The mean of corneal endothelial density pre surgery is $3126 \text{ cells/mm}^2 \pm 246,1$ and the mean of corneal endothelial density post-surgery is 3029 cells/mm^2 . The range of surgery time is 6-30 minutes. With the mean time of surgery $13,7 \pm 5,8$ minutes. From 52 eyes there are 45 eyes with corneal endothelial cells loss 7 days after surgery, with the mean of corneal endothelial cells loss after cataract phacoemulsification surgery are $152,3 \pm 68 \text{ cells/mm}^2$, the percentage mean was 6%, and we found decreasing in central corneal thickness, corneal endothelium density, hexagonality and increasing coefficient of variety.

Keywords: cataract; corneal endothelium; phacoemulsification

INTRODUCTION

The main optical structure of the eyes is the lens and corneal because lens with the cornea, focuses image of the visual world onto the retina. Both of the main optical structure is affected by age, it affects the corneal endothelial cells and transparency of the lens. By aging the corneal endothelial cells decrease and the lens loses its transparency then the cataract appears [1,2]. A cataract is a cloudy area in the lens of eye. Because of the proteins of the lens start to break down. It begins to change from normal eye after age 40 and people over age 60 usually start to have some clouding in their lenses [4]. It is known that cataract surgery effecting the corneal endothelial cells number. The surgery will be decreasing the corneal endothelial cells number. The severity to which endothelium is affected depends on many factors, such as phacoemulsification time and energy, surgical technique, anterior chamber depth, and use of ophthalmic viscoelastic devices (OVDs) [3].

Phacoemulsification is a modern cataract surgery first developed by Charles Kelman in 1967. From the small incision 2-3 mm characterous lens could be emulsified, giving perfect visual outcome [5]. The new phacoemulsification systems cataract surgery become a safer procedure. This combines fewer surges, lower amounts of ultrasound and more controlled anterior-chamber depth, as well as a lower incidence of thermal burns at the incision site. Endothelial corneal pump function controlling corneal transparency which can be disrupted by surgical trauma [6].

A healthy cornea is essential for maintaining good vision. The central corneal thickness (CCT) and the morphology of the corneal endothelial cells are the two crucial parameters in the functional and morphological assessment of the cornea for diagnostic purposes and before any intraocular surgery. Normal corneal endothelial cell density (CED) at birth is between 4000 and 5000 mm^2 , which decreases by 0.3-0 with age.6% per year with an approximate value of 2000-3000 cells/mm^2 in a normal adult eye. CED has been found to decrease with age, trauma, refractive surgery, intraocular surgery, glaucoma, corneal dystrophies, and diabetes mellitus (Islam, 2017). Human corneal endothelial cells (HCECs) play a critical role in maintaining corneal transparency by controlling the hydration of the corneal stroma. Decreased HCEC, mainly due to possible decompensation from previous intraocular surgery, trauma, corneal endotheliitis, and corneal endothelial dystrophy, resulting in corneal edema with visual impairment [7]

RESEARCH METODOLOGY

This research is a descriptive study and was conducted at Mata Utama Clinic, Gresik, East Java, Indonesia from June-July 2022. The sample in this study were patients with a diagnosis of cataract who met the research criteria, with inclusion criteria which is all patients with cataract; agreed to do cataract surgery in June 2022; and has been examined with a specular microscope.

The data were primary data obtained through direct interviews with respondents. Researchers prepare data collection sheets and write down the results on a data collection sheet containing patient identity data (age and gender), diagnosis, results of pre-surgery endothelial corneal cells count, the complication of surgery, time of surgery and 7 days post-operative endothelial corneal cells count.

The diagnosis of cataract uses patient's symptoms and eye examination such as visual acuity; refraction; cover test; slit lamp examination (pupillary response, adnexal examination, cornea, anterior chamber, lens, and fundus examination) [8]. The stage of cataract is based on the lens appearance in slit-lamp examination such as hyper mature cataract (This is a dense white opacity that obscures the red reflex and contains milky fluid within the capsule, a result of degenerated lens cortex), mature cataract (This is a cataract that is opaque, totally obscuring the red reflex), immature cataract (This is a cataract characterized by a variable amount of opacification, present in certain areas of the lens), and incipient cataract (This is a cataract that is seen on slit-lamp examination but is of little clinical significance) [9].

RESULTS

The research was conducted from June to July 2022, starting from making research proposals, collecting data and reporting research results. The data is taken directly when the patient is in the examination room after surgery of Mata Utama Clinic Gresik, East Java, Indonesia.

TABLE 1: Table of Cataract patient's demographic

Gender(eyes)	Men	Women
Age	31	21
Mean	43,77± 8 years	57± 6,1 years
Range	43-77	48-71
location of cataract (eyes)		
Right	18	16
Left	13	5
Cataract's stage (eyes)		
Hiperature	0	0
Mature	9	2
Immature	22	19
Insipient	0	0

From the data collected, a sample of 52 eyes was obtained in 52 patients. Demographic data in Table 3.1 shows that most of the patients are men (59,6%), and the rest are women (40,4%). The age range of this patient in this study was 43-77 years with a mean age 57,7 ± 7,8 years. Most of the diagnosis cataract are in stage cataract immature, namely 79%, and the rest are in stage of cataract mature, namely 21%. From 52 eyes that has been diagnosed with cataract 65,4% were in the right eyes and 34,6% were in the left eyes.

TABLE 2: Table of specular microscope examination result and surgery time

	Mean ± SD
Pre-operative result	
Central corneal thickness (CCT)	511,8mm ± 38,1
Corneal endothelial density (CED)	3126 cells/mm ² ± 246,1
Coefficient of variation (CV)	33,1 ± 3,5
HEX	33,9% ± 8,7
Surgery time (min)	
	13,7 ± 5,8

	Mean ± SD
Post-operative (D+7)	
Central corneal thickness (CCT)	509,6mm ± 42,7
Corneal endothelial number (CED)	3029 cells/mm ² ± 352,5
Coefficient of variation (CV)	33,9 ± 4,1
HEX	31,4% ± 10,2
Corneal endothelial loss	
	152,3 ± 68 cells/mm ²

From 52 eyes shows that the mean of corneal endothelial density pre surgery is 3126 cells/mm² ± 246,1, with the highest corneal endothelial number is 3476 cells/mm² and the lowest corneal endothelial number is 2087 cells/mm². The mean of corneal endothelial density post-surgery is 3029 cells/mm², with the highest corneal endothelial number is 3369 cells/mm² and the lowest corneal endothelial number is 1859 cells/mm². From 52 eyes there are 45 eyes with corneal endothelial cell loss. The mean of corneal endothelial loss from 45 eyes after the surgery is 152,3 ± 68 cells/mm² and the percentage mean were 6%. From table 3.2 shows that the range of surgery time is 6-30 minutes. With the mean time of surgery 13,7 ± 5,8 minutes. There are view surgery which last longer than the other surgery. The surgery which takes 30 minutes have some complication while in surgery such as subluxation, and post glaucoma. The surgery which takes 27 minutes have anterior fibrosis complication, but there is a 24-minute surgery that doesn't has any complication. There are some other complications in another surgery in this study such as shallow camera oculi anterior, pupil can't be wide, synechia, and fibrosis posterior capsule. All the phacoemulsification surgery in the Mata Utama Clinic Gresik used viscoelastic.

DISCUSSION

Cataract is the main cause of vision impairment and blindness which strongly related with aging [10]. Globally, at least 2.2 billion people have a vision impairment. In at least 1 billion of the cases, vision impairment could have been prevented or has yet to be addressed which 94 million people got visually impaired by cataract [11]. Cataract is an eye disease which affect the clearness of lenses so it became opacified and will obscure the passage of light. The onset is gradual and commonly seen in the older age group mostly happen in the fifth and sixth decade [8]. That matter is accordance to this study the mean age of patients in men is 43,77 ± 8 years and the mean age in women is 57 ± 6,1 years, which the range of age in this study is 43-77 years. There are many factors that responsible for developing cataract such as congenital cataract, senile cataract, traumatic injury systemic disease, endocrine disease, primary ocular disease drugs, poor nutrition, alcohol use disorder and smoking, but the most commonly type of cataract is senile cataract. Cataract is more common in women than a man with male and female ratio 1:1,3 [8]. This matter is different from this study, in this study we found more than a half is men, namely 59,6% and the rest are women, namely 40,4%, this can be caused by the inclusion of this study namely, patients who are agreeing to have surgery. For maintaining the clarity of corneal, healthy cornea is very important. There are two important parameters in evaluating corneal functional and morphological for diagnostic and before any intraocular surgery, namely CCT (central corneal thickness) and corneal endothelial cell morphology [12,13,14]. There isn't significant difference in corneal endothelial characteristics between men and women or right and left eyes, except the CCT value is higher in women [15]. Intraocular surgery procedure performed for minimizing corneal endothelial damage.

In this study we use specular microscope to evaluate the safety of new surgical procedure, intraocular lenses, and agents for intraocular use. Knowing endothelial cell count before surgery is useful for knowing surgical risks for the patient. The normal endothelial corneal cell count is 1500 to 3500 cells/mm² form age 40-90, and it will decrease by age [16]. In this study the preoperative mean corneal endothelial cell count is 3126 cell/mm² ± 246,1, with the highest corneal endothelial cell count is 3476 cells/mm², and the lowest corneal endothelial number is 2087 cells/mm². The corneal must be able to withstand surgical trauma, which when the corneal endothelial cell count is in the upper range, the corneal may be able to withstand it, because it retains a sufficient density of endothelial cells even after greater endothelial loss. [16]. For helping to maintain the corneal transparency, the endothelium cornea uses its barrier and ionic “pump” functions. The CED must be at least higher than the critical number usually 400-500 cells/mm² to maintain the corneal transparency [17,18,19]. To compensated damage to corneal endothelium cells, it is compensated by a combination enlargement and cell spread to cover up for lost cells, which resulting decrease cell density, increase in size of cells with increased cellular pleomorphism and decrease in hexagonality [12,13,14]. In table 3.2 seven days after surgery in specular microscope examination result, we found decreasing in central corneal thickness, corneal endothelium density, hexagonality and increasing coefficient of variety. In this study we found that 7 days after surgery the mean corneal endothelial loss from 45 eyes were 152,3 ± 68 cell/mm² and the percentage mean were 6%. This data in the study is in accordance with some other study that found after uncomplicated surgery endothelial cell loss has been reported to vary from 4-25% [20,21]. At birth the normal corneal endothelial density is between 4000-5000 cells/mm², which will decline by aging at 0,3-0,6% per year with CED value of 2000-3000 cells/mm² in a normal adult eye [12,22,23]. The rate of endothelial loss increases 4 times, namely 2,5%/year for at almost 10 year after surgery [24]. But there is a patient in this study that has more than 25% corneal endothelial cell loss, and one patient with the same corneal endothelial cell number before and after surgery. We found too that from 52 eyes, there are 7 patients that has more endothelial corneal number after surgery. Cataract surgery is well known to decreasing the number of corneal endothelial cells, the endothelial corneal cell loss is affected by variety factors such as phacoemulsification time and energy, surgical technique, anterior chamber depth and use of ophthalmic viscoelastic devices [6,25,26,27]. Further research needs to be carried out with the same study but longer time of evaluation post-operative such as examination of specular microscope 1 month /4 month after surgery.

CONCLUSION

From the total 52 eyes, there are 45 eyes with decreasing corneal endothelial number. the mean of corneal endothelial cells loss after cataract phacoemulsification surgery are 152,3 ± 68 cells/mm² and the percentage mean were 6%. we found that decreasing in central corneal thickness, corneal endothelium density, hexagonality after surgery and increasing coefficient of variety.

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