Corneal changes after phacoemulsification in white cataract

Gehad Fawzy[1], Dalia Sabry[2], Sameh Saleh[2], Walid Gaafar[2]

1: MBBCH, Mansoura University

2: Ophthalmology Department, Faculty of Medicine, Mansoura University, Egypt.

Corresponding author: Gehad Fawzy Sliem**.** Ophthalmology Department, Faculty of Medicine, Mansoura University, Egypt**.** PO. 35516.Te. 01063766353 E-mail: drgehadfawzy@gmail.com

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Abstract

Purpose of the study is to asses corneal astigmatism, central corneal thickness and endothelial cell density after white cataract surgery using phacoemulsification.

Patients and methods: Prospective interventional and analytical study that was conducted to asses corneal astigmatism, central corneal thickness and endothelial cell density after white cataract surgery using phacoemulsification, The study was included 30 eyes of 30 patients who had white cataract and attended the outpatient clinic of the Mansoura Ophthalmic Center and underwent phacoemulsification from January 2020 to January 2021.

Results: there was statistically highly significant difference between pre-operative and all consecutive follow up visits in central corneal thickness, endothelial cell density and visual acuity with no statistically significant difference in corneal astigmatism.

Conclusion: Although phacoemulsification is effective in management of white cataract on anatomical and refractive bases, there is marked endothelial cell loss.

Key words: White cataract, phacoemulsification, Central corneal thickness, Endothelial cell density, Astigmatism, Visual acuity.

INTRODUCTION:

Cataract is the most well-known treatable visual impairment on the planet. A cataract is named mature if the cortex and core become so hazy that the red fundus reflex is missing, the cortex turns out to be widely hydrated; this is the stage where the lens looks white. In emerging nations white mature cataracts are seen habitually[1].

Phacoemulsification is the most utilized method in cataract surgery on the planet. It enjoys the benefits of the more modest cut, less injury to the eye, just as more limited activity time and quick visual recovery[2].

Careful expulsion of white mature cataracts presents unique difficulties to the specialist. It is related with high pace of intraoperative and postoperative complexities, for example, inadequate continuous circular capsulorrhexis (CCC), spiral tears in front container stretching out to equator and posterior capsule, break of posterior capsule, vitreous misfortune, nucleus drop, Intraocular Lens (IOL) disengagement, corneal consumes, Intraocular pressure (IOP) rise, tireless corneal edema and anterior chamber response[3-5].

Consistent curvilinear capsulorrhexis and emulsification of hard nucleus are two basic advances that make phacoemulsification testing in these cases. Perception of the anterior capsule relies upon red reflex, which is compromised in eyes with white mature cataract. The capsule is extra delicate and leakage of condensed cortical material causes the capsulorrhexis tear to stretch out to the fringe because of high intracapsular pressure. The anterior capsule might go through crumbling with testimony of calcium or development of central plaques might upset the capsulorrhexis[6].

The utilization of Trypan blue works with CCC development, gives a protected a surgery, bringing about decline in intraoperative confusions. nucleus of changing hardness might be concealed by absolutely hazy cortex. After the nucleus is taken out by divide and conquer or the phaco chop technique, a posterior chamber intraocular lens can be

embedded. In any event, for an accomplished specialist harder nucleus will require a more drawn out time and higher force of phacoemulsification. A plaque or residual posterior capsule is seen notwithstanding effective surgery[7].

It is realized that white, intumescent and hypermature cataracts have a high intracrystalline pressure (ICP). CCC is started in the constant way and because of the conceivable abrupt loss of tension distinction between the ICP, the anterior chamber pressure (ACP) and the vitreous chamber pressure (VCP), there is a danger of a spiral tear towards the periphery of the anterior capsule, with the potential inconveniences of augmentation of the tear to the posterior capsule, loss of vitreous and fall of the nucleus into the vitreous[8].

In these cases, it is always better to begin with a smaller capsulorrhexis with ensuing growth, which should be possible even after the intraocular lens has been set and focused inside the capsular bag. Yearning with a 27-or 30-measure needle preceding commencement of the capsulorrhexis might be advantageous to de-pressurize a bloated lens and forestall radialization of the capsulorrhexis[9].

Endothelial cell misfortune can happen during cataract surgery for an assortment of reasons, including actual contact between the corneal endothelium and the lens, harm from the phacoemulsification energy, misfortune from water system liquid, air bubble harm, contact with nuclear fragments, or poisonous impacts from intracameral prescriptions[10].

PATIENTS AND METHODS

Prospective interventional and analytical study that was conducted to asses corneal astigmatism, central corneal thickness and endothelial cell density after white cataract surgery using phacoemulsification.

The study included 30 eyes of 30 patients who had white cataract and attended the outpatient clinic of the Mansoura Ophthalmic Center from January 2020 to January 2021 to do phacoemulsification and asses corneal astigmatism, central corneal thickness and endothelial cell density pre and post operatively.

Inclusion criteria:

-White cataract patients (intumescent, mature and hyper mature cataract) of both sexes aged from 50-70 years. .

Exclusion criteria:

Patients of Glaucoma, Previous ocular surgery, Cataract other than age related, Corneal opacities or scars, Diabetic retinopathy, Lens dialysis, Poor pupillary dilatation or pseudoexofoliation, Fuch's endothelial dystrophy .

After endorsement from the institutional review board of Mansoura Faculty of Medicine and getting an educated composed assent from the members, all cases were exposed to finish history taking.

- Full detailed ophthalmic examination was done for all the cases including assessment of the visual acuity, Light projection to test the function of the retinal periphery, Color perception by Ishihara charts to test the function of the macula, Ocular tension measurement with Goldman Applanation tonometer, Slit lamp examination of the Anterior segment looking for: Cornea: for clarity (scars, opacities, keratic precipitates, fuch's endothelial dystrophy and descemetoceles), Anterior chamber: its depth and regularity, Pupil: state of its dilatation and Lens: intumescent, mature and hyper mature cataract.

Clinical investigations:

- Biometry and IOL power calculation using (AL-Scan Optical Biometer).
- B scan ocular ultrasonography to evaluate the posterior segment using (US-4000 Echoscan).
- Scheimpflug photography (TMS-5 Pentacam) to determine the preoperative corneal astigmatism and central corneal thickness.
- Specular microscopy (Tomey EM-3000) to measure the endothelial cell density.

Operative Technique (Figure 1)

Phacoemulsification was done by the same surgeon (Prof. Dr Sameh Saleh) using the same phaco Machine (Oertli CataRhex machine) and same IOL type (OPTIFLEX hydrophobic foldable IOL). Patient with any complications during surgery or prolonged phaco time was excluded to avoid the complication effect on the corneal measurements.

Adequate Sterilization using povidone iodine (10% for skin and 5% for conjunctiva), Application of wire speculum, Two corneal side ports by 20-G MVR blade at 2 & 10 o'clock was made, then Stepped corneal incision was made by keratome, 2.8 mm width at 12 o'clock, then 0.75 ml of Trypan blue stain

0.055% was injected under air bubble to allow visualization of the capsule since there's no initial red reflex with dense white cataract, Viscoelastic material (methyl cellulose to protect corneal endothelium and Healon to keep the AC formed) were injected , Capsulorrhexis was initiated by a cystotome and he used rhexis forceps to adjust anterior capsulorrhexis (5 mm in diameter).

If the CCC margin extended to the periphery, the capsulotomy was completed using a capsulorrhexis forceps from the opposite direction.

In intumescent cataract the AC was fully formed with Healon to flatten the anterior capsule, 30G needle on a 0.3 mm syringe was inserted to delicately puncture the paracentral area of the anterior lens capsule and gentle pressure on the nucleus allowing the liquefied lens content to be released from posterior intralenticular compartment through the equator into the AC and aspirated.

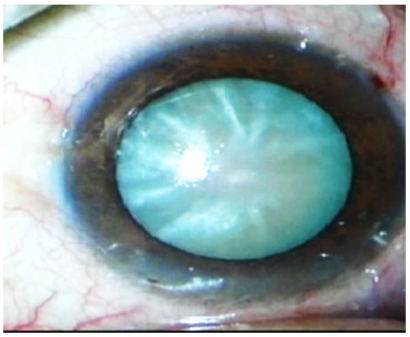
Capsulorrhexis was then continued by formation of radial cut in the anterior capsule with cystotome and completed using a capsulorrhexis forceps, Minimal hydro dissection rarely used in some cases and mobilizing the nucleus to release any posterior adhesions, Nucleus was removed by phaco chopping technique using the Oertli CataRhex machine to prevent damage to corneal endothelial cells as more energy is used in hard cataracts.

The machine parameters were adjusted as follow: Power was 30%-50% (continuous), Vacuum 350-450mm Hg, Flow rate 20-25 cc/min.

Irrigation and aspiration (I/A) of the cortical matter was then performed, Foldable posterior chamber IOL was implanted into the bag. The IOLs was acrylic hydrophobic foldable lens and the injection was given through an injecting device, then Removal of any remaining viscoelastic material was done through irrigation and aspiration and Closure of the wound was performed by stromal hydration.

No intra cameral antibiotics or adrenaline were used to avoid the adverse effect on corneal endothelium.

Finally, a 1 ml combination of broad-spectrum antibiotic and steroid was injected subconjunctivally.



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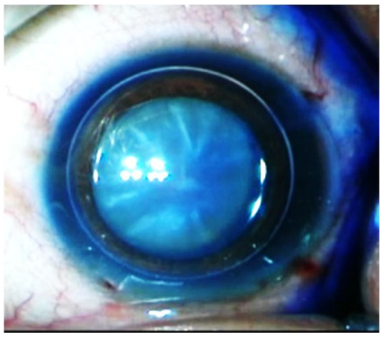

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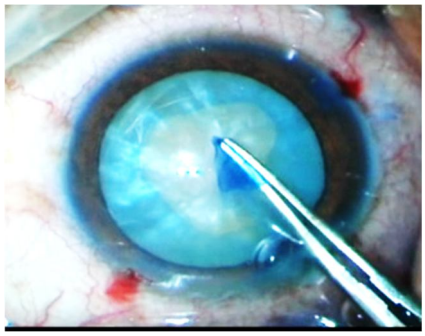

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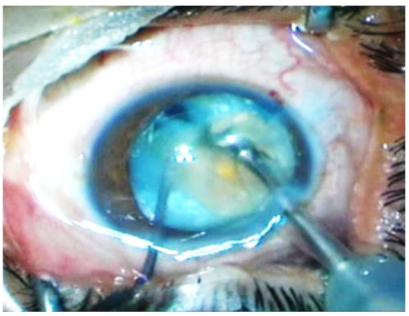

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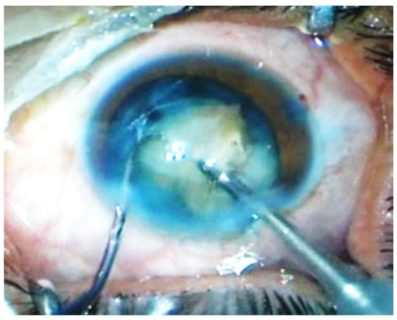

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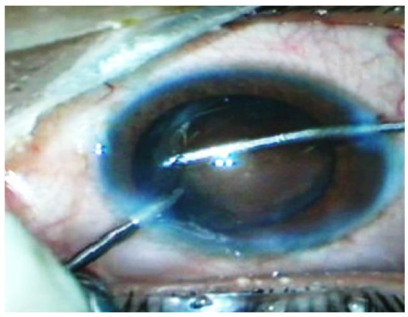

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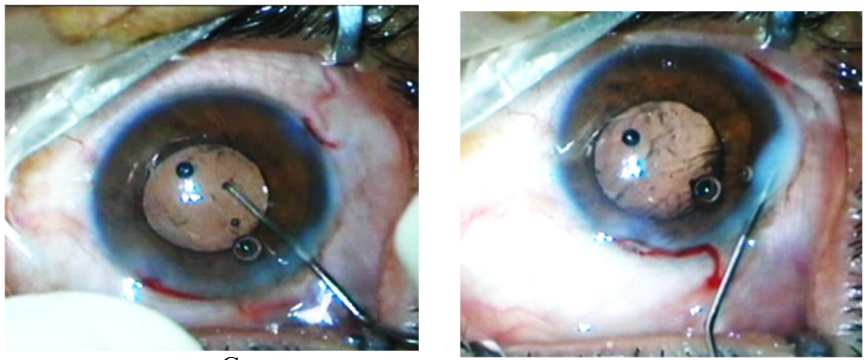


G H

Fig.1: Phaco. Operation: **A**: pre-operative, **B**: capsular staining by trypan blue, **C**: capsulorrhexis, **D,E**: phaco chopping, **F**: I/A of the cortex, **G**: IOL implantation, **H**: stromal hydration

Post –operative follow –up:

All patients were examined 1st post-operative day by slit lamp only then at 1 week, 1 month and 3 months after surgery for:

- **Unaided visual acuity and Best corrected visual acuity by Snellen chart**
- **Slit lamp biomicroscopy to assess:** State of the cornea for edema, clarity, state of incision and IOL position and stability
- **Post-operative corneal astigmatism and central corneal thickness** were measured using a Scheimpflug photography (TMS-5 Pentacam).
- **Post-operative endothelial cell density** was measured using specular microscopy (Tomey EM-3000).

Statistical analysis of Data

The study was performed at 95% level of significance and power of 80%. The collected data were coded, processed and analysed using the SPSS (Statistical Package for Social Sciences) version 26 for Windows® (SPSS Inc, Chicago, IL, USA).

Qualitative data was presented as number (frequency) and Percent. Quantitative data was tested for normality by Kolmogorov-Smirnov test. Parametric data (Normally distributed data) was presented as mean ± SD. Wilcoxon-Signed rank test was used to compare patients in the same groups at different time points.

♣ P-value > 0.05: Non-significant

♣ P-value < 0.05: Significant

♣ P-value < 0.01: Highly significant

RESULTS

The study was carried out on 30 eyes of 30 patients with white cataract whose ages ranged from 51 to 75 years underwent phacoemulsification.

The mean age of the patients was 61 ± 7.45, this group included 17 males and 13 females.

Medical history:

12 patients (40%) were diabetic, 4 patients (13.3%) were hypertensive, 6 patients (20%) were diabetic and hypertensive and 8 patients (26.7%) were free. (Fig. 2)

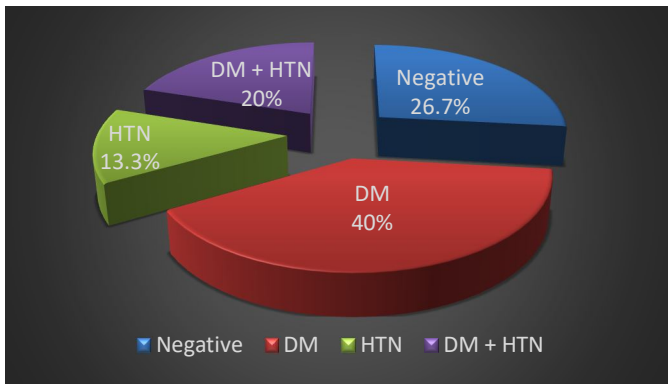


Fig. 2: Medical history

Corneal astigmatism:

The corneal astigmatism was **not significant** between pre-operative and all consecutive follow up visits. It was initially (1.23 ± 0.81) pre-operative then increased to (1.35 ± 1.08) at 1-week post-operative then returned to normal (1.23 ± 1.05) at 1-month post-operative and more decrease (1.19 ± 0.93) at 3 months post-operative. (Fig. 3)

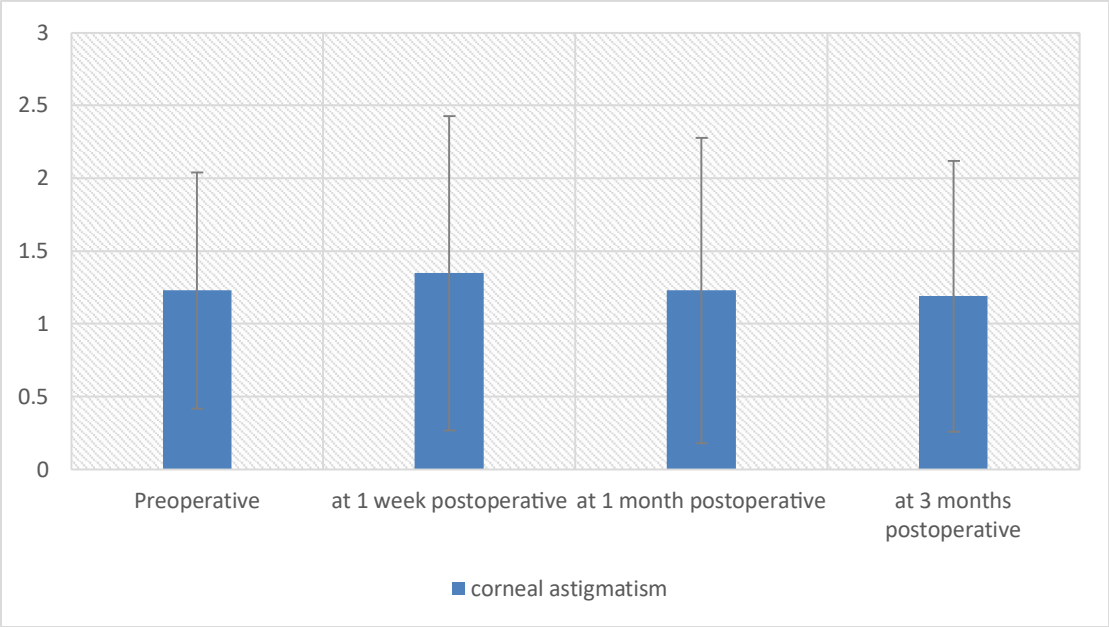
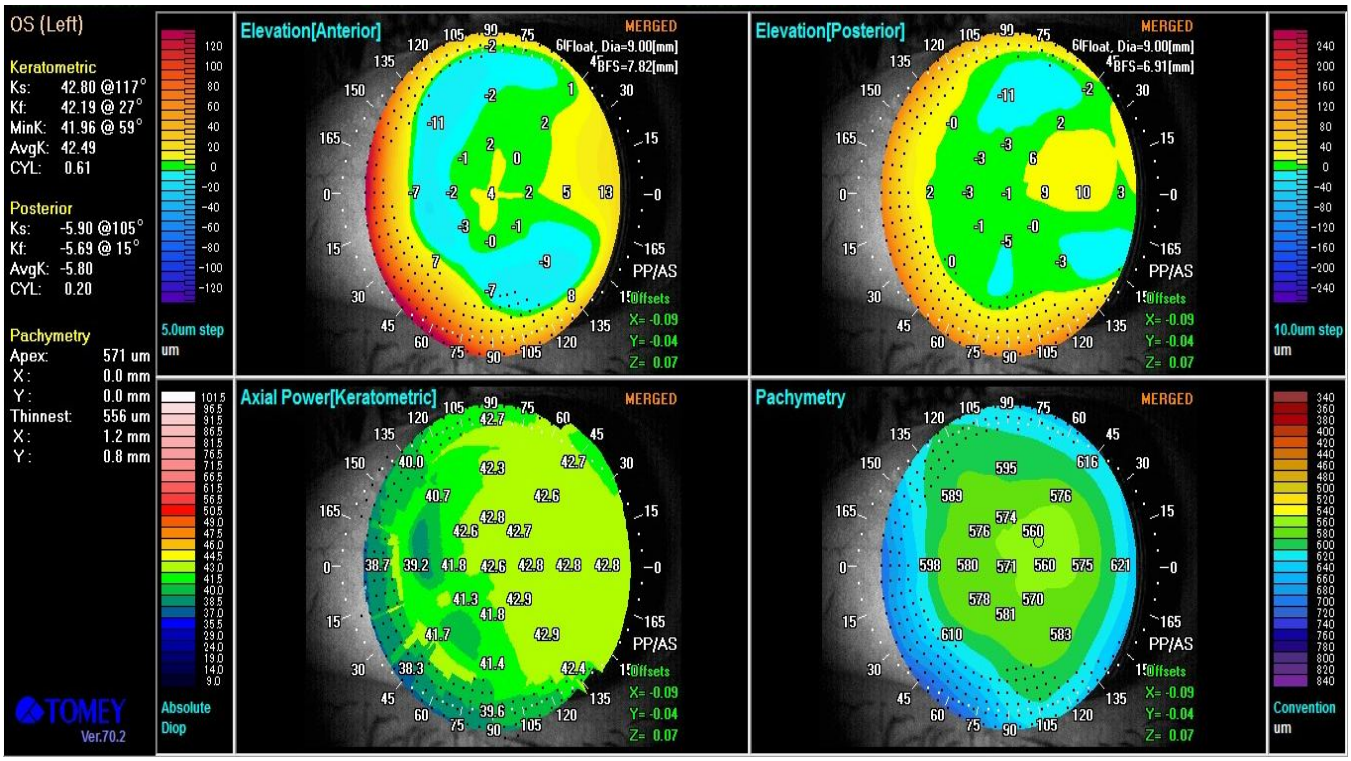


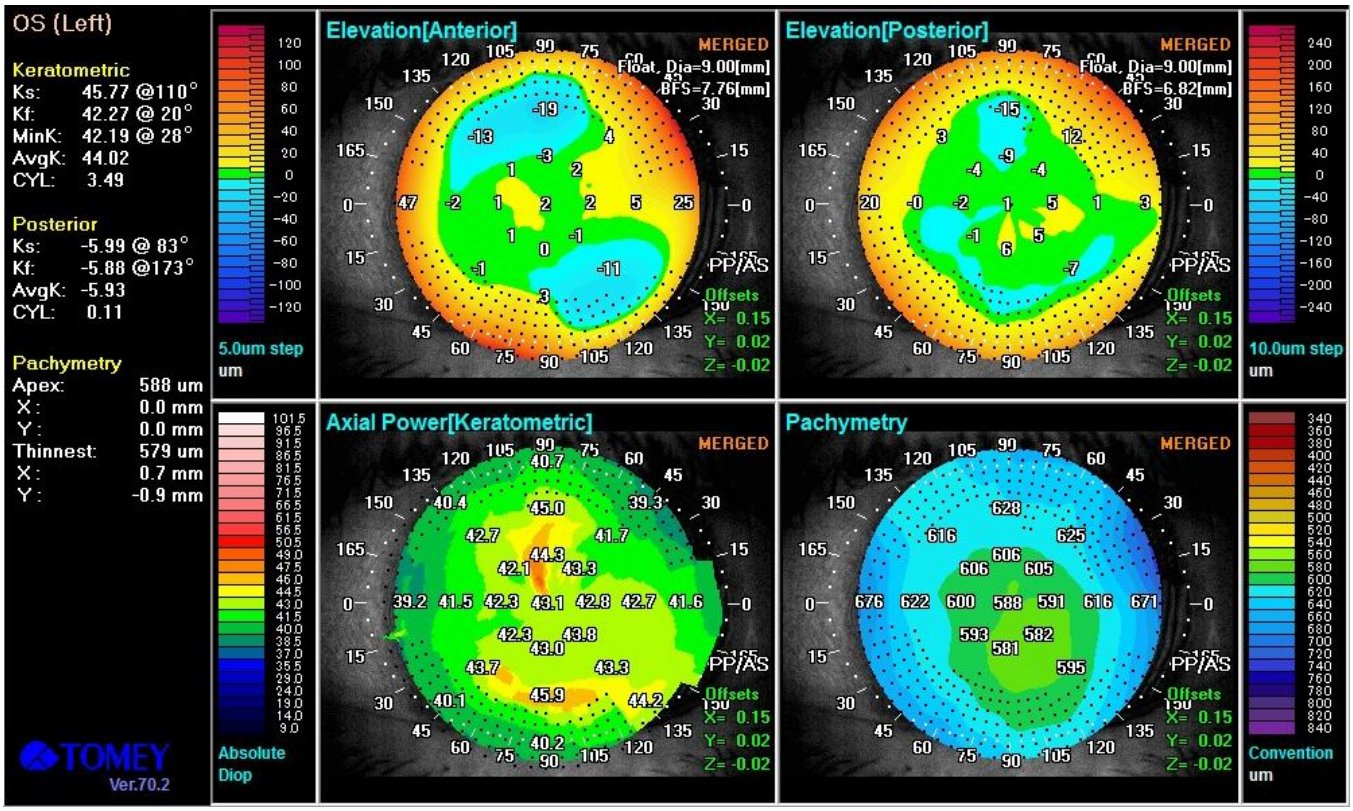
Fig. 3: Corneal astigmatism

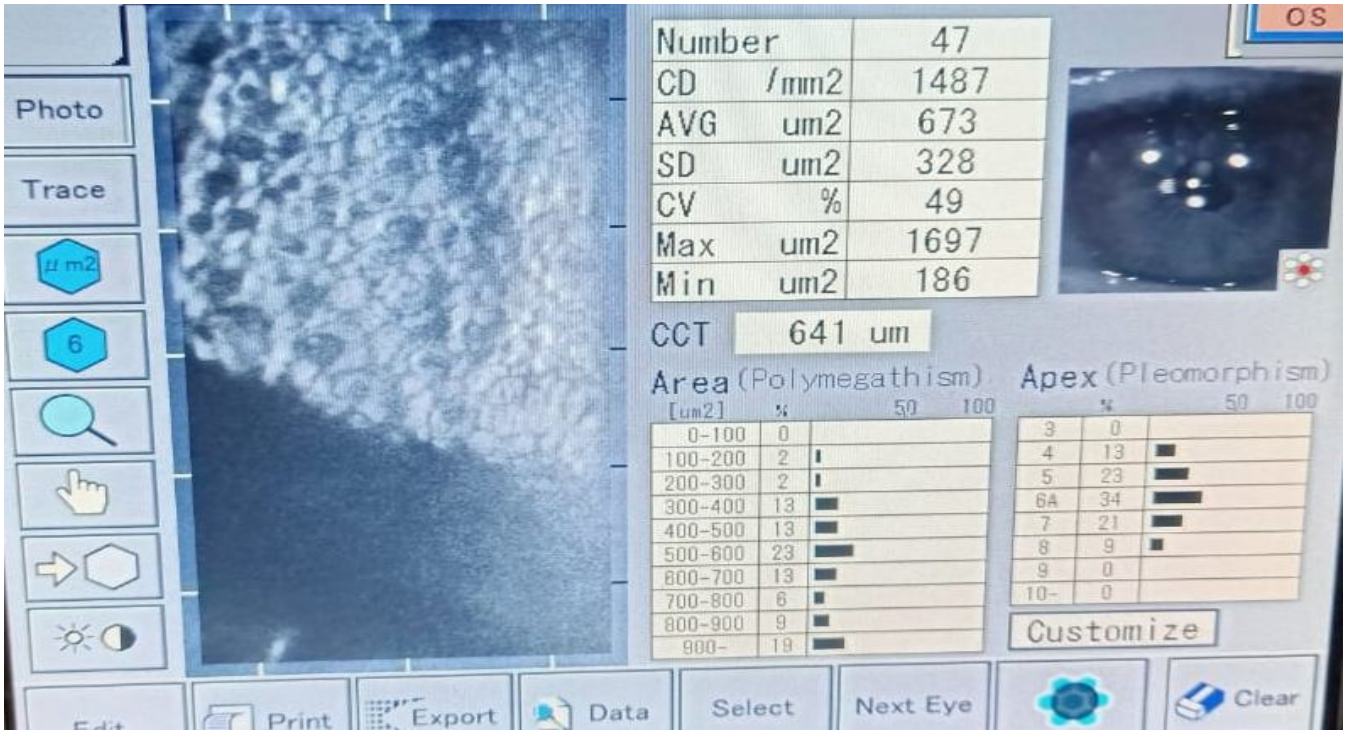
Case presentation:

Pre operative

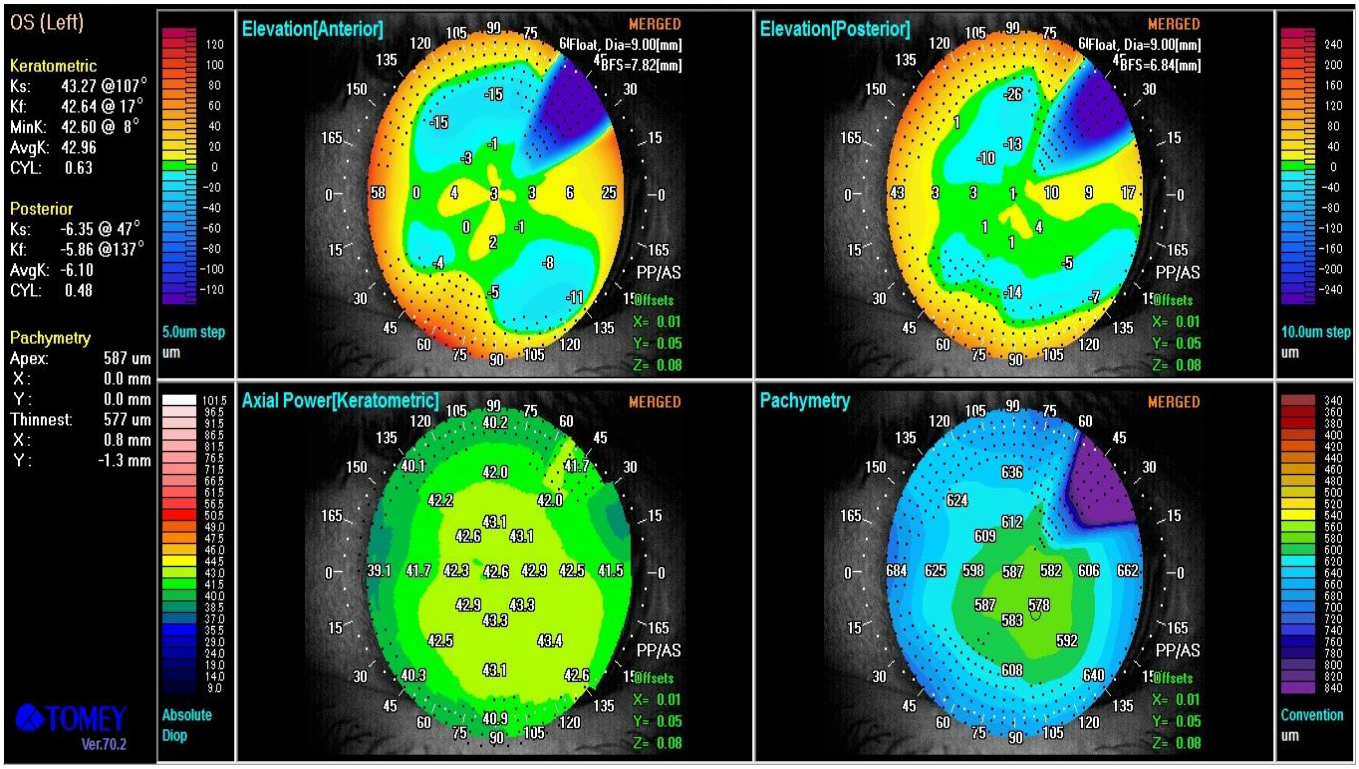


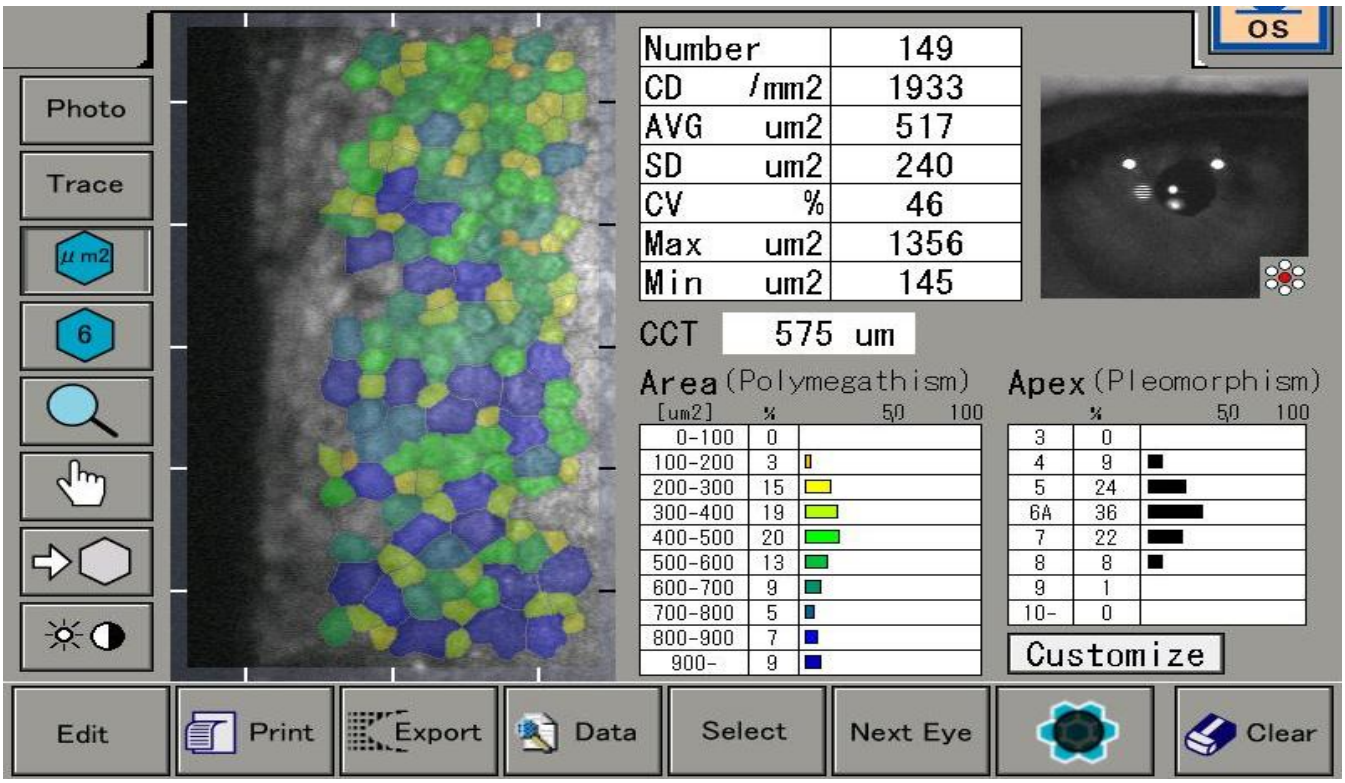
After one week:





After one month:





Central corneal thickness:

The central corneal thickness (CCT) showed a statistically **significant** difference between pre-operative and all consecutive follow up visits. It was initially (516.93 ± 19.29µm) pre-operative then rose to (555.87± 18.35µm) at 1-week post-operative then decreased at 1-month (536.93 ± 18.90 µm) and returned near to normal (525.73 ± 16.53) at 3-months post-operative with percent of CCT increase **1.5%**. (Table 1)

Table 1: Central corneal thickness

	(phaco-emulsification) (N=30)	P value
Preoperative	516.93 ± 19.29	
at 1 week postoperative	555.87± 18.35	<0.001*
at 1 month postoperative	536.93 ± 18.90	<0.001*
at 3 months postoperative	525.73 ± 16.53	0.002*
Percent of change	1.5 (-0.93: 5.38)	

P: probability. Continuous data are expressed as (mean ± SD)

*: statistically significant (p< 0.05)

Endothelial cell density:

The endothelial cell density showed a statistically **significant** difference between pre-operative and all consecutive follow up visits. It was initially (2605.20 ± 259.20 cell/mm^2) pre-operative then decreased to (1918.53 ± 328.91 cell/mm^2) 1-week post-operative, at 1-month post-operative the endothelial cell count increased to (2119.80 ±264.33 cell/mm^2) and more increase at 3-months post-operative (2312.13 ± 242.72 cell/mm^2) with percent cell loss about **9.09 %.** (Table 2)

Table 2: Endothelial cell density

	(phaco-emulsification) (N=30)	P value
Preoperative	2605.20 ± 259.20	
at 1 week postoperative	1918.53 ± 328.91	<0.001*
at 1 month postoperative	2119.80 ± 264.33	<0.001*
at 3 months postoperative	2312.13 ± 242.72	<0.001*
Percent of change	-9.09 (-22.88: -3.33)	

P: probability. Continuous data are expressed as (mean ± SD)

*: statistically significant (p< 0.05)

Visual acuity (VA):

The visual acuity (VA) showed statistically significant improvement in all post-operative follow up; it was (0.45 ± 0.23) at 1-week post-operative then (0.32 ± 0.19) at 1-month post-operative then became (0.18 ± 0.07) at 3-months post-operative. (Table 3)

Table 3: visual acuity

	(phaco-emulsification) (N=30)	P value
at 1 week postoperative	0.45 ± 0.23	<0.001*
at 1 month postoperative	0.32 ± 0.19	<0.001*
at 3 months postoperative	0.18 ± 0.07	0.003*

P: probability. Continuous data are expressed as (mean ± SD)
*: statistically significant (p< 0.05)

DISCUSSION

White mature cataracts are difficult for cataract specialist and convey a few challenges. The most basic advance of phacoemulsification medical procedure is Continuous Curvilinear Capsulorrhexis. In case it isn't finished, some intraoperative inconveniences, for example, posterior capsule crack, vitreous misfortune and nucleus drop might happen. Since the red reflex is compromised in white as cataract, it is hard to finish CCC securely. Trypan blue gives safe CCC[11].

Kara junior et al., (2009)[12] suggested the mini rhexis procedure for white intumescent cataracts in which fundamentally a little CCC was performed then extended. Two stages CCC forestalled unexpected outspread tears of the underlying capsulotomy because of raised intra capsular tension[12].

Phacoemulsification of hard nucleus requires higher ultrasonic energy, which is somewhat changed over to warm energy causing corneal endothelial harm and corneal consumes. Liquid elements during phacoemulsification might cause endothelial cell harm if it keeps going longer[13]. With aging, endothelial cell count diminishes, this is one more danger for patients with mature cataracts; subsequently, a chance of post-operative corneal edema is higher in patients with mature cataract[14].

This study noticed that there were significant decline of the endothelial cell density and significant increment of the central corneal thickness in the first week and first month according to preoperative state and returned close to ordinary at 90 days with percent cell misfortune around 9.09%

Tang et al., (2017)[15] concurred with our result that he found that patients have an essentially lower ECD at all post-operative time directs in connection toward preoperative state, eyes with respectably hard cataract patients were exposed to different changes because of cataract extraction procedure[15].

Additionally, ***Osman, A. et al., (2019)***[16] announced that a worth of 16.6% loss of endothelial cell density after phacoemulsification of grade 3 hard senile cataract first month post-operative and that expansion up to 3% till the third month post-operative[16].

Bamdad, S. et al., (2018)[17] revealed a significant decline in ECD from 2,791.15±99.86 to 2,472.87±472.14 representing an endothelial cell loss (ECL) worth of 11.4%in expansion to showing a huge expansion in central corneal thickness from 530.47±2.60 to a worth of 540.91±36.07on post-operative Day 1. The reflected 1.8% expansion in CCT could be clarified by corneal edema happening because of harm to corneal endothelium, which is explicitly seen in patients having higher ECL[17].

Gonzalez-Salinas and colleagues (2018)[18] concurred with these outcomes that patients after phacoemulsification had a lower endothelial density by 12-14 %[18].

Fernández-Muñoz et al., (2019)[19] concentrate on that followed up the endothelial misfortune in the span time of 1month and 90 days post-operatively which uncovered critical decline in endothelial cells in both the present moment and long term[19].

Bourne RR et al., (2004)[20] support our review, revealed that adjustment of cell density all through the cornea after phacoemulsification by 90 days[20].

Fakhry MA et al., (2011)[21] additionally reasoned those corneal changes after phacoemulsification corneal thickness returned almost to benchmark multi month after surgery, while endothelial misfortune persisted, being compensated by the remaining endothelial cells[21].

This study noticed that phacoemulsification in white cataract gave incredible visual acuity improvement with

neutral astigmatism ***Linebarger et al., (1999)***[22] announced that the visual recuperation was considerably faster due to less induced astigmatism, often diminishing the postoperative visual restoration time[22].

CONCLUSION:

This study showed that there's decrease in the ECD and increase in the CCT which returned near to normal at 3 months with excellent visual acuity and neutral astigmatism.

Although phacoemulsification has been satisfactory, effective and anatomical in management of white cataract, there was marked endothelial cell loss.

Recommendations

It is recommended that a detailed assessment of endothelial cell count preoperatively and according to it specific phacoemulsification technique used and phaco parameters and phaco dynamics used to reach the least endothelial cell loss and refine the current surgical methods and instruments to minimize the endothelial damage.

DATA AVAILABILITY

All data are included in this article.

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None

Conflict of Interest

Authors declare no conflicts of interest.

Corresponding author

Correspondence to: Gehad Fawzy

Email: drgehadfawzy@gmail.com

Affiliations

Gehad Fawzy, Mansoura University, Egypt.

Ethics declarations

Conflict of interest

Gehad Fawzy, Dalia Sabry, Sameh Saleh, Walid Gaafar all authors have no conflicts of interest that are directly relevant to the content of this review.

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