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Endothelial Cell Loss after Phacoemulsification According to Different Anterior Chamber Depths in Hard Cataract

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Abstract

Background: Phacoemulsification which is performed through a limited space (anterior chamber of the eye) carries the risk of endothelial cell loss (ECL). So, the aim of this study was to compare the loss of corneal endothelial cells after phacoemulsification according to different anterior chamber depths in hard cataract.

Aim of Study: Compare the loss of corneal endothelial cells after phacoemulsification according to different anterior chamber depths. Differences in cumulative dissipated energy, Endothelial cell loss among the anterior chamber depth groups.

Patients and Methods: Prospective study on 30 eyes of 25 patients with senile cataract of nuclear opalescence grade 3 (NO3) divided into 2 groups according to anterior chamber depth: group A >2.99mm & group B < OR=2.99mm. intraoperative mean cumulative dissipated energy (MCDE) and the used irrigation solution volume were measured. Clinical examination and investigation include Best Corrected Distance Visual Acuity and Endothelial cell count (ECC) that measured preoperative, one week and 2 months postoperative.

Results: No statistical significant difference between the two groups in MCDE and irrigation solution volume. Preoperative ECC was statistical significant higher in group A than B and become highly statistical significant higher in group A than B 1 week and 2 months postoperative. ECL was statistical significant higher in group B than A 1 week and 2 months postoperative. In each group there was high statistical significant improvement in best corrected visual acquity 1 week and 2 month postoperative.

Conclusion: The current study concluded that shallow anterior chamber depth is a risk factor for endothelial cell loss in hard cataract (NO3) in phacoemulsification cataract surgery. So, surgeons should pay more care in patient with shallow anterior chamber depth with hard cataract densities.

Key Words: *Endothelial cell loss – Phacoemulsification – Anterior chamber depths – Hard cataract.*

Introduction

IT is known that corneal endothelium dose not regenerate, and its density decreases with the ageing process. That may showing average annual reduction of 0.6%. And this process only compensated for by the migration, enlargement, and increasing heterogeneity of the cells **[1,2]**.

Minimal stress to endothelium can change cell shape and size, but more stress may cause cell loss and change the cytoskeleton of endothelium **[3]**. Stress elements can be metabolic (hypoxia or hyperglycemia), toxic (e g. drugs), traumatic (e g. surgery), or change in pH and osmolarty **[4]**.

When the endothelial cell count reached a threshold of 500 cells/mm^2, endothelial decompensation develop with irreversible corneal edema and haze **[5]**.

It is known that endothelial cell loss after phacoemulsification influenced by some preoperative and intraoperative parameters. Such as, the age, nucleus hardness, ultrasound energy, time, technique of the phacoemulsification, and infusion volumes **[6-9]**.

Phacoemulsification surgery is performed in the anterior chamber of the eye which is a limited space and formation of adequate surgical space during the operation can decrease the risk of corneal endothelial cell loss. Thus, anatomical factor as adequate anterior chamber depth may be important for securing endothelial cells from the mechanical and thermal effect of the phacoemulsification procedure. It is well known that ultrasound time (UST) and ultrasound power are important risk factors for endothelial cell loss after phacoemulsification **[6]**.

Studies have postulated that ECL not affected by anterior chamber depth (ACD) post phacoemulsification surgery **[10]**. But, such studies did not pay careful attention to factors as MCDE, UST,

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and irrigation solution volume [11]. So, In order to better evaluate endothelial cell loss after phacoemulsification according to different anterior chamber depths. This study done on only one type of cataract nuclear opalescence with considerable hardness and calculate the cumulative dissipated energy (CDE), ultrasound time (UST), and irrigation solution volume used and consider them as confounding factors.

Patients and Methods

Type of study: Prospective, interventional study.

Study setting: Randomly selected patients from Zagazig ophthalmic hospital out patient that undergo phacoemulsitication and posterior chamber foldable intraocular lens implantation at Zagazig Ophthalmic Hospital.

Study period: Examination and phacoemulsitication Surgery start from September 2018 to November 2019.

Study population: Patient randomly selected with the following inclusion and exclusion criteria:

Inclusion criteria:

1- Age group of patients between 55 and 65 years old.

2- Nucleus opalescence (NO.) grade 3 according to Lense Opacities Classification System III (LOCS III) [12].

3- Endothelial cell count b/w 1500-3000 cells/mm^2.

Exclusion criteria:

1- Patients with history of diabetic mellitus.

2- History of previous intraocular surgery or ocular trauma or inflammation.

3- Preoperative diagnosis of glaucoma.

4- Pseudo-exfoliation or corneal pathology.

5- Intraoperative complications, such as iris trauma, descemet's detachment, Posterior capsule rupture with vitreous loss.

6- Postoperative complications.

Sampling method: Randomly selected cases from zagazig ophthalmic hospital out patient who undergo phacoemulsitication. Cataract surgery, we divide patients into 2 groups according to anterior chamber depth of Group A >2.99mm & Group B < OR=2.99mm measured by E-Z SCAN AB5500+ UltraSound (SONOMED INC.,USA) (Fig. 1), guided by Anterior chamber depth studies [13].

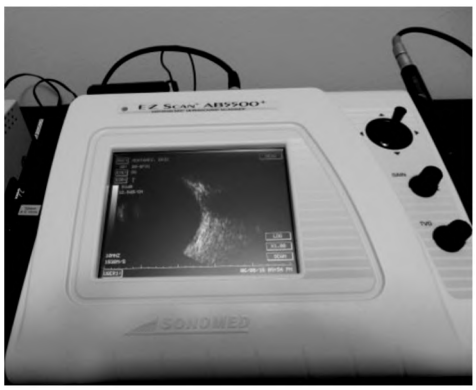

Fig. (1): E-Z scan AB5500 + UltraSound (SONOMED Inc., USA).

Sample size: 30 eyes of 25 patients.

Ethical considerations: All patient will be consent to be included in the study after explanation of the procedure and follow-up course.

Study procedures:

Pre operative assessment:

1- Corrected distance Visual acuity using snellen chart, slitlamp examination and dilated fundus examination.

2- Intra ocular lens power and anterior chamber depth calculation (mm) using E-Z SCAN AB5500 + A/B UltraSound (SONOMED INC., USA), five consecutive measurments were recorded and averaged. The procedure needs local anesthesia, as the probe contacts the eye. the A-scan transducer is 10 MHz and its resolution is 200μm with 100 to 120μm accuracy [14].

3- Endothelial cell count using noncontact NIDEK CEM-530 specular microscope (Nidek Co., Ltd., gamagori, Japan) (Fig. 2), the center method was used with attached images of corneal endothelium measurement at a field of coverage of 0.25 x 0.5mm of the central cornea.

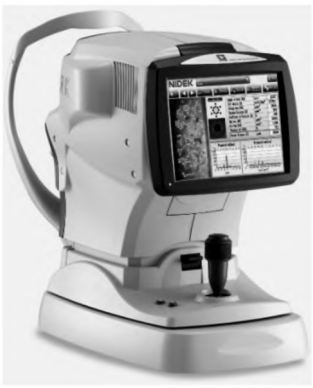

Fig. (2): NIDEK CEM-530 specular microscope (Nidek Co., Ltd., gamagori, Japan).

Surgical technique:

- Phacoemulsification well be performed by the same surgeon.
- Oertli vision system (OS3 NovitreX3000) (Fig. 3) and standard straight 45 degree angled tip will be used in all of the surgeries.

Fig. (3): Oertli vision system (OS3 Novitre X3000).

- Phacoemulsitication power set in pulsed mode , peristaltic aspiration flow rate set at 28ml/min, the height of the infusion bottle was 90cm and vacium set around 350mm Hg.
- In all of the cases, a clear corneal incision will be made at 12 o'clock position with a 2.8mm keratom & two side ports will be made by MVR Blade.
- Anterior capsule will be stained with trypan blue stain under protection of the corneal endothelium by air.
- Then, the ophthalmic viscosurgical Device will be injected into the anterior chamber. About 5mm continuous curvilinear capsulorhexis will be made using cross action straight Capsulorhexis Forceps (Tisurg, China) (Fig. 4).

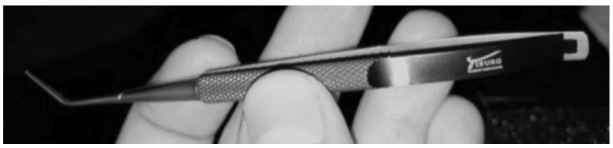

Fig. (4): Cross action straight Capsulorhexis Forceps (Tisurg, China).

- Hydrodissection and hydrodelineation will be performed using an irrigation solution.
- In all of the cases, the “divide-and-conquer” technique will be used for phacoemulsification. That is, four trenches will be sculpted, and the nucleus will be divided bimanually into four segments, after which the four divided quadrants will be emulsified in the capsular bag. Next, methylcellulose will be injected into the anterior chamber and capsular bag, and an Intra Ocular Lens will be implanted in the capsular bag.
- In all of the cases, the hydrophilic acrylic one piece foldable Intra Ocular Lens (ocuflex, India) (Fig. 5) will be implanted by disposabe accompanying injector under the protection of methylcellulose, which will be subsequently removed through irrigation and aspiration. The clear corneal wounds will be hydrated.

Fig. (5): Hydrophilic acrylic one piece foldable Intra Ocular Lens (ocuflex, India).

Post-operative assessment:

1- After 1 day; slitelamp examination.

2- After 1 weak:

- Slitelamp examination.
- Best Corrected Distance Visual Acuity.
- Endothelial cell count using noncontact NIDEK CEM-530 specular microscope (Nidek Co., Ltd., gamagori, Japan).

3- After 2 months:

- Slitelamp examination.
- Best Corrected Distance Visual Acuity.
- Endothelial cell count using noncontact NIDEK CEM-530 specular microscope (Nidek Co., Ltd., gamagori, Japan).

Intraoperative and postoperative measurements & invistigations:

Intraoperative measurements included; total irrigation solution volume used, ultrasound time, and mean cumulative dissipated energy (ultrasound time in relation to phaco power).

Postoperative invistigations included; Endothelial cell count Will be measured at 1 weak, 2 months using noncontact NIDEK CEM-530 specular mi-

croscope (Nidek Co., Ltd., gamagori, Japan), the center method was used with attached images of corneal endothelium measurement at a field of coverage of 0.25 x 0.5mm of the central cornea.

Statistical analysis:

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 20. Quantitative variables were described using their means and standard deviations. Categorical variables were described using their absolute frequencies and were compared using chi square test when appropriate. Kolmogorov-Smirnov (distribution-type) and Levene (homogeneity of variances) tests were used to verify assumptions for use in parametric tests. To compare quantitative data between two groups, Mann Whitney test (for not normally distributed data) and independent sample *t*-test (for normally distributed data) were used. When p value is significant, Fisher LSD post hoc test (for one way ANOVA) was used to uncover specific differences between two groups. Wilcoxon signed ranks test was used to compare variables that were non normally distributed. Spearman rank correlation coefficient was used to determine direction and strength of correlation between two quantitative variables (where one of them or both are not normally distributed). The level statistical significance was set at $p<0.05$. Highly significant difference was present if $p\leq 0.001$.

Results

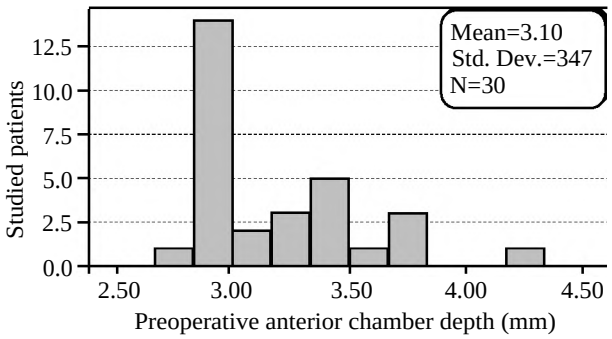

Fig. (6): Frequency distribution of the studied patients according to the preoperative anterior chamber depth.

Table (1): Demographic data of the two studied groups.

Variables	Group A (n=15)	Group B (n=15)	Test of sig.	*p*
Age (years):			*t*	0.03
Mean ± SD	58.1±3.4	60.9±3.4	2.2	S
Sex, n (%):			χ^2	
Male	6 (40.0%)	7 (46.7%)	1.4	0.7
Female	9 (60.0%)	8 (53.3%)		
Affected side, n (%) :			χ^2	
Right	9 (60.0%)	10 (66.7%)	1.4	0.7
Left	6 (40.0%)	5 (33.3%)		

This table shows that the total number (30 eyes) of studied patients (25) in two groups according to anterior chamber depth.

Table (2): Comparison between the studied groups in preoperative parameters.

Variables	Group A (n=15)	Group B (n=15)	*t*	*p*
CDVA (decimal):				0.01
Mean ± SD	0.27±0.04	0.23±0.05	2.6	S
Log MAR CDVA:				0.01
Mean ± SD	0.57±0.06	0.65±0.08	2.8	S
ECC (cells/mm ^{2}):				0.001
Mean ± SD	2615.0±272.0	2292.4±201.1	3.7	S

CDVA: Corrected distance visual acuity.

This table shows preoperative ECC for the first group was 2615.0±272.0 and 2nd group was 2292.4±201.1 with statistically significant difference and the corrected distance visual acquity was also significant between two groups preoperative.

Table (3): Comparison between the studied groups in operative parameters.

Variables	Group A (n=15)	Group B (n=15)	*t*	*p*
U/S time (second):				0.4
Mean ± SD	57.0±8.9	59.7±8.1	0.9	NS
MCDE:				0.6
Mean SD	11.7±3.6	12.4±2.8	0.5	NS
Irrigation solution (ml):				0.06
Mean ± SD	95.3±11.9	104.0±12.4	2.0	NS

This table shows no statistical significant difference between two groups in mean ± SD of ultrasound time, MCDE and irrigation solution.

Table (4): Comparison between the studied groups in 1-week postoperative parameters.

Variables	Group A (n=15)	Group B (n=15)	Test of sig.	*p*
CDVA (decimal):			*t*	0.06
Mean ± SD	0.77±0.1	0.70±0.1	1.8	NS
Log MAR CDVA:			*t*	0.06
Mean ± SD	0.12±0.06	0.16±0.06	1.8	NS
ECC (cells/mm ^{2}):			*t*	<0.001
Mean ± SD	2452.3± 289.3	2034.5± 255.1	4.2	HS
Endothelial cell loss (%):			MW	0.01
Mean	5.7	10.2	2.4	S
Range	0.92-12.6	4.2-20.5		

This table shows high statistical significant difference in ECC of the two groups 1 week postoperative and the endothelial cell loss was statistical significant difference between the two groups, while there was no statistical significant difference between them in CDVA.

Table (5): Comparison between the studied groups in 2-months postoperative parameters.

Variables	Group A (n=15)	Group B (n=15)	Test of sig.	*p*
CDVA (decimal):			*t*	0.002
Mean ± SD	0.96±0.08	0.85±0.09	3.3	S
Log MAR CDVA:			*t*	0.002
Mean ± SD	0.02±0.04	0.07±0.05	3.3	S
ECC (cells/mm ^{2}):			*t*	<0.001
Mean ± SD	2424.2± 288.0	2000.5± 262.8	4.2	HS
Endothelial cell loss (%):			MW	0.02
Mean	6.5	11.5	2.3	S
Range	2.0-13.3	5.0-22.8		

This table shows high statistical significant difference in ECC of the two groups 2 month postoperative and the endothelial cell loss and CDVA was statistical significant difference between the two groups 2 month postoperative.

Table (6): Preoperative and postoperative BCVA (decimal) in the studied groups.

BCVA (decimal)	Group A (n=15)	Group B (n=15)
Preoperative:		
Mean ± SD	0.27±0.04	0.23±0.05
1-week postoperative:		
Mean ± SD	0.77±0.1	0.70±0.1
2-months postoperative:		
Mean ± SD	0.96±0.08	0.85±0.09
F	485.0	295.9
p	<0.001 (HS)	<0.001 (HS)

In each group there was high statistical significant improvement in best corrected visual acquity 1 week and 2 month postoperative.

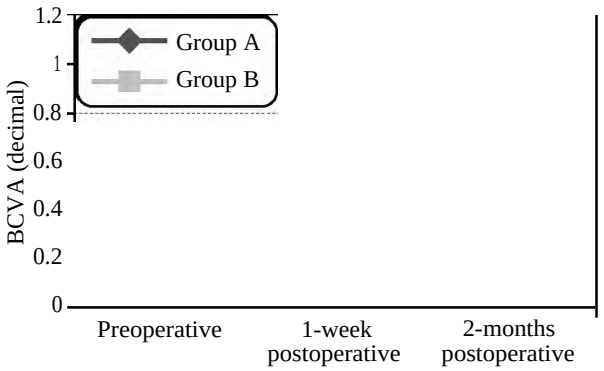

Fig. (7): Preoperative and postoperative BCVA (decimal) in the studied groups.

Table (7): Preoperative and postoperative log MAR CDVA in the studied groups.

Log MAR CDVA	Group A (n=15)	Group B (n=15)
Preoperative:		
Mean ± SD	0.57±0.06	0.65±0.08
1-week postoperative:		
Mean ± SD	0.12±0.06	0.16±0.06
2-months postoperative:		
Mean ± SD	0.02±0.04	0.07±0.05
F	627.2	423.7
p	<0.001 (HS)	<0.001 (HS)

In each group there was high statistical significant improvement in best corrected visual acquity 1 week and 2 month postoperative.

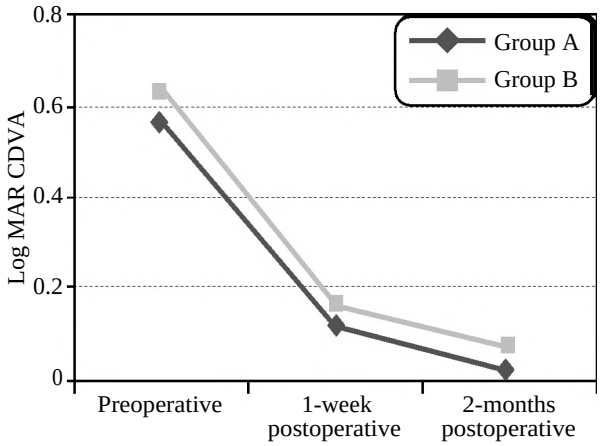

Fig. (8): Preoperative and postoperative log MAR CDVA in the studied groups.

Table (8): Preoperative and postoperative ECC in the studied groups.

ECC (cells/mm^2)	Group A (n=15)	Group B (n=15)
Preoperative:		
Mean ± SD	2615.0±272.0	2292.4±201.1
1-week postoperative:		
Mean ± SD	2452.3±289.3	2034.5±255.1
2-months postoperative:		
Mean ± SD	2424.2±288.0	2000.5±262.8
F	32.8	95.0
p	<0.001 (HS)	<0.001 (HS)

In each group there was high statistical significant difference in endothelial cell count 1 week and 2 month postoperative.

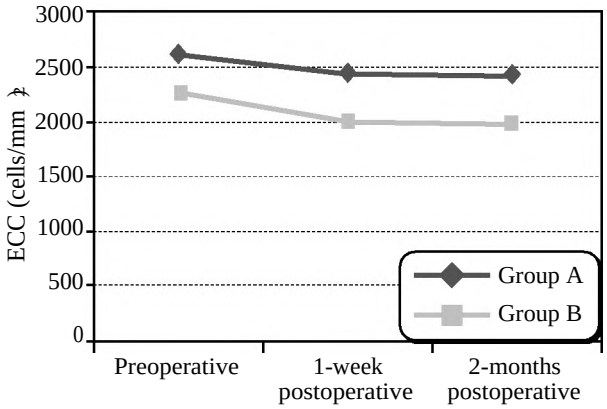

Fig. (8): Preoperative and postoperative log MAR CDVA in the studied groups.

In each group there was statistical significant difference in endothelial cell loss 1 week and 2 month postoperative.

Table (9): Endothelial cell loss in the studied groups.

Endothelial cell loss (%)	Group A (n=15)	Group B (n=15)
1-week postoperative:		
Median	5.7	10.2
Range	0.92-12.6	4.2-20.5
2-months postoperative:		
Median	6.5	11.5
Range	2.0-13.3	5.0-22.8
WS	3.4	3.4
p	0.001 (S)	0.001 (S)

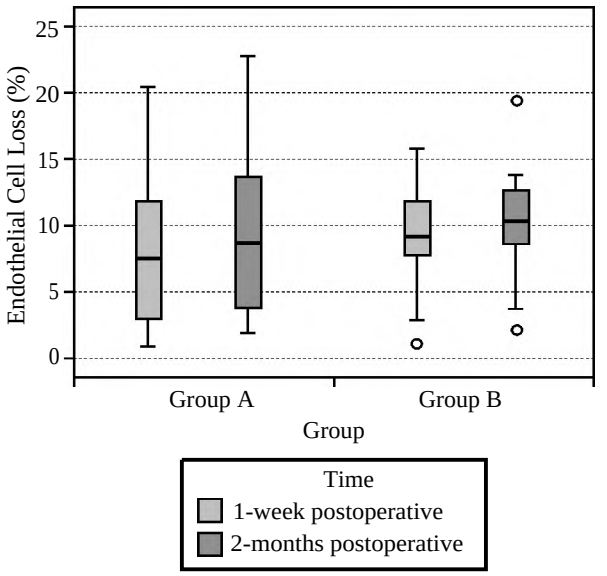

Fig. (10): Preoperative and postoperative ECC in the studied groups.

Discussion

Corneal endothelial cells are not regenerated once they are damaged [11] and had a pump function which keep Cornea transparent, this pump can be affected by surgical trauma [15]. Thus, endothelial cell loss should be assisted because one of the common complication of cataract surgery was corneal decompensation [16].

Operative data (e g. length of corneal tunnel, duration of surgery, ultrasound power average, phacoemulsification time, turbulence of irrigation solution, corneal trauma by instruments, intraocular lens or nuclear fragments, intraocular lens type, viscoelastic used type) were related to endothelial cell loss [17,18]. Preoperative data (e.g. age, diabetes mellitus, short axial length, or crystalline lens nuclear hardness) were also related to endothelial cell loss [19,20]. Postoperative complications (e g. capsular rupture and vitreous loss) also increased endothelial cell loss [21].

In order to control for this risk factors, this Prospective, interventional study has a limited age range (58.1±3.4 in group A and 60.9±3.4 in group B) with mild significant statistical difference (p0.03) between the two groups and it excluded Patients with history of diabetic mellitus, previous intraocular surgery, ocular trauma or inflammation, Preoperative diagnosis of glaucoma, Pseudo-exfoliation, corneal pathology, Intraoperative or Postoperative complications and all patient has nuclear cataract opalescence (NO.) grade 3 according to Lens Opacities Classification System III (LOCS III).

The technique of the phacoemulsification may affect the loss of endothelial cells. Storr-Paulsen et al., [22] postulated that divide-and-conquer technique produce more loss in the endothelial cells than phaco chop technique, due to the additional energy used by the divide-and-conquer technique to cracks the nucleus. Thus, such technique is the better for study the anterior chamber depth (ACD) influence on the endothelial cell loss [11], which was done in this study. Also, an expert surgeon with sufficient phacoemulsification surgical skills was essential in standardizing the operative results [16] and so, all surgeries done by the same surgeon with expert skills.

Cataract surgery is done in the anterior chamber of the eye which is confined space, and corneal endothelium appears to be more exposed during the surgery if its depth was short. So, more significant surgical trauma may result [10]. This study

hypothesized that a deep anterior chamber depth would correlate with lower endothelial cell loss during phacoemulsification surgery and in order to compare endothelial cell loss during phacoemulsification surgery according to different anterior chamber depths, The durrent study divide patients into 2 groups according to anterior chamber depth (Group A >2.99mm & Group B < OR=2.99 mm measured by immersion A-scan ultrasound) guided by Anterior chamber depth study **[13]**. That compared ACD in 492 eyes measured by careful immersion A-scan ultrasound (U/S) and optical pachymetry and found that ACD was 2.99±0.51mm by U/S (0.18mm shorter than optical pachymetry that cannot be corrected by U/S velocity) and careful immersion A-scan US may be less reliable in measuring ACD than optical pachymetry. So, further studies using optical pachymetry in ACD measurements may be needed.

In the current study, there was no statistical significant difference between the two groups in operative parameters U/S time (second) (57.0±8.9 in group A, 59.7±8.1 in group B), mean cumulative dissipated energy (MCDE) (11.7±3.6 group A, 12.4±2.8 group B) measured by the phaco machine and total irrigtion solution volume (ml) (95.3 in group A, 104.0 in group B). This Parameters was comparable with the study of Hwang et al., **[11]** where patients with (nuclear opalescence grade 3) devided into 3 different anterior chamber depth groups with U/S time (second) was (52.75, 54.36 and 52.65), MCDE was (10.16, 10.56 and 9.21) and total irrigation solution volume (ml) was (79.74, 70.65 and 73.95).

The preoperative best corrected distance visual acuity (CDVA) in Log MAR was (0.57±0.06 in group A, 0.65±0.08 in group B) which highly statistical improved at one week (0.12±0.06 in group A, 0.16±0.06 in group B) and 2 months (0.02±0.04 in group A, 0.07±0.05 in group B) postoperative in each group with no statistical significant difference between the two groups at 1 week postoperative this coinsides with Hwang et al., **[11]** that show preoperative best corrected distance visual acuity in Log MAR (0.51 in ACD 1, 0.49 in ACD 2, 0.46 in ACD3) which statistical improved at one day, one month and 2 months postoperative with no statistical significant difference between the 3 ACD groups. This result was the same if the best corrected distance visual acuity measured in decimal form.

Also in the current study preoperative endothelial cell count (ECC) (2615.0±272.0 in group A and 2292.4±201.1 in group B) was comparable with other studies eg. Reuschel et al., **[10]** ECC was 2401 [2321-2511], **[16]** ECC was (2524.94), **[11]** ECC was 2658.20, 2646.27, 2602.47 in three different anterior chamber depths, but show some significant statistical difference between the two groups (this may partial coinside with the significant statistical difference in age between them and also may be related to small sample size).

It was known that endothelial cell count decreases with ageing, Møller-Pedersen **[23]** postulated a 0.3% decrease of ECC by year. Niederer et al., **[24]** postulated a 0.5% decrease by year. Jorge et al. (2010) show ECC reduction of 5-6% by 10 years. Cheng et al., **[25]** tolled about up to 1 % reduction of endothelial cell count every year. Even if, phacoemulsification surgery decreases ECC further more. Hwang et al., **[11]** show endothelial cell loss of 4.01-12.94% 2 month postoperative, Park et al., **[26]** postulated 5.2-9.1% loss of endothelial cells by 2 months after phacoemulsification. This is similar to current study results (5.7% in group A, 10.2% in group B) and (6.5% in group A, 11.5% in group B) one week and two months postoperative respectively. Also, Mehra and Verma **[16]** show with nucleus opalescence grade 3 endothelial cell loss at day 1, 1 week and 6week 357.96 cells/mm^2 (14.18%), 395.27 cells/mm^2 (15.65%) and 424.88 cells/mm^2 (16.83%) respectively and Reuschel et al., **[10]** show endothelial cell loss of 5.2% (range 1.7%-7.6%) 3 month postoperative. This may show some difference and may be attributed to variation in the patient selection criteria and the technique and technology used in the phaco surgery.

Storr-Paulsen et al., **[8]** found 3.5-5.7% endothelial cell loss 12 months postoperative. So, endothelial cell loss appears to continue for at least one year after phaco surgery more than that of normal ageing process and further studies should be done with longer postoperative follow-up period.

Current study results show that anterior chamber depth could be a risk factor for increasing endothelial cell loss and there is statistical significant cell loss more in group B with shallow anterior chamber depth than group A and the ECC difference between the two groups changed from statistical significant preoperative to highly statistical significant either one week or 2 months postoperative, also there is statistical significant reduction of ECC from one week to 2 months postoperative in each group.

There have been contradicting reports about this result of the current study, Hwang et al., **[11]** compared three ACD groups according to nuclear

cataract density and found that the percentage of corneal endothelial cell loss was higher in the ACDI group than in the ACDIII group in eyes with NO3 and NO4 nuclear densities and shallow ACD could be a risk factor for increasing endothelial cell loss during phacoemulsification. McCarey et al., [27] found that endothelial cell damage can occur by surgical instruments especially in eyes with shallow anterior chamber. Walkow et al., [9] showed that in short eyes there is a small confined surgical space with increased risk of endothelial touch by instruments and lens fragments and may be a risk factor for endothelial cell loss during the phacoemulsification. But, could not show a relationship between anterior chamber depth and endothelial cell loss. Against the current study Reuschel et al., [10] concluded that ACD, axial length or lens density were not identified as risk factors of postoperative endothelial cell loss. O'Brien et al., [6] show that axial length or anterior chamber depth has no relationship with endothelial cell loss during phacoemulsification, as the irrigation flow can produce a sufficient surgical space. Jung et al., [28] compared nanophthalmic and relative anterior microphthalmic eyes with a control group of normal eyes in phacoemulsification surgery and found more endothelial cell loss in nanophthalmic eyes (mean ACD, 1.82mm) than relative anterior microphthalmic (mean ACD, 1.87mm) and a normal control (mean ACD, 2.70mm) eyes but with no statistical significant results. Those studies unlike the current study did not control for the other risk factors that can affect endothelial cell loss during phaco cataract surgery.

Limitations:

The current study limitation is the small sample size (30 eyes of 25 patients), short follow-up duration period and use immersion A-scan US that may be less reliable in measuring ACD than optical pachymetry.

Conclusion:

The current study concluded that shallow anterior chamber depth is a risk factor for endothelial cell loss in hard cataract (NO3) in phacoemulsification cataract surgery. So, surgeons should pay more care in patient with shallow anterior chamber depth with hard cataract densities.

Recommendations:

So, further studies with more enrolled patients, longer follow-up duration period and use of optical pachymetry in measuring anterior chamber depth should be done.

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فقدان الخلايا البطانية بعد استحلاب العدسة وفقاً للأعماق المختلفة للغرفة الأمامية فى الساد الصلب

هذه الدراسة التداخلية تمت على مرضى تم إختيارهم بطريقة عشوائية من العيادات الخارجية بمستشفى طب وجراحة العيون بالزقازيق (٥٥-٦٥ سنة) والذين كانوا يعانون من المياه البيضاء (الساد) مع تصلب العدسة من الدرجة الثالثة وخضعوا لعملية إستحلاب العدسة وزرع عدسة قابلة للطى فى الحجرة الخلفية داخل العين وكان عدد الخلايا البطانية للقرنية لديهم ما بين ١٥٠٠-٣٠٠٠ خلية/مم٢. وتم إستبعاد مرضى الداء السكرى أو من تعرضوا لجراحة سابقة أو رضوض أو إ لتهابات فى العين، المياه الزرقاء، تقشر محفظة العدسة الكاذب أو أى أ مراض أخرى بقرنية العين، والمرضى الذين يعانون من مضاعفات أثناء العملية أو ما بعد الجراحة. تم تقييم ما قبل الجراحة وما بعد الجراحة بيوم واحد واسبوع واحد وشهرين من حيث حدة الإبصار والفحص بالمصباح الشقى وعدد الخلايا البطانية للقرنية.

وتم تقسيم المرضى الخاضعين للدراسة (٣٠ عيناً لدى ٢٥ مريض) إلى مجموعتين حسب عمق الغرفة الأمامية. وقد وجد أن عدد الخلايا المبطنة للقرنية قبل الجراحة للمجموعة الأولى كانت أعلى قليلاً وبشكل ملحوظ نسبياً من مثيلتها بالمجموعة الثانية مع وجود فرق بسيط لحدة الإبصار بين المجموعتين. ولا يوجد فرق يذكر لإجمالى حجم المحلول المستخدم، ولا لوقت الموجات فوق الصوتية المستخدمة، ولا لمتوسط الطا قة الفعلية للموجات فوق الصوتية المستخدمة بين المجموعتين أثناء العملية. وأظهرت النتائج إنخفاض كبير لعدد الخلايا المبطنة للقرنية لكلا المجموعتين بعد اسبوع وبعد شهرين من العملية وكانت نسبة فقد الخلايا فى المجموعة الثانية أعلى بشكل ملحوظ من المجموعة الأولى كما كانت نسبة فقد الخلايا لكلا المجموعتين بعد اسبوع أقل منها بعد شهرين من العملية وأصبح عدد الخلايا المبطنة للقرنية للمجموعة الثانية أقل بكثير من المجموعة الأولى. وتحسنت حدة الإبصار بالمجموعتين بشكل كبير بعد اسبوع وبعد شهرين من العملية كما كانت حدة الإبصار بالمجموعة الأولى أعلى منها بالمجموعة الثانية بشكل غير ملحوظ بعد اسبوع وملحوظ بعد شهرين من العملية.

وخلصت الدراسة إلى أن عمق الخزانة الأمامية الضحل فى حالات المياه البيضاء ذات التصلب الشديد للعدسة (الساد الصلب) هو عامل خطر لفقدان الخلايا البطانية أثناء عملية المياه البيضاء بالموجات فوق الصوتية استحلاب العدسة ولذلك يجب أن يؤى الجراح مزيداً من الحرص أثناء العملية للمرضى أصحاب الخزانة الأمامية ذات العمق الضحل.