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Original Article

Endoillumination Assisted Phacoemulsification in Patients with Hazy Cornea

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ABSTRACT

Background: Worldwide, cataract is the main cause of blindness. It accounts for 55% of 41 million blind. Visual restoring is made by cataract surgery.

The aim of the work: This study designed to evaluate the use of endoillumination system in phacoemulsification in patients with hazy cornea and to assess its efficacy, complications, and the best way of using it.

Patients and Methods: A prospective study included 40 eyes with cataract and hazy cornea were scheduled for cataract surgery, at Al-Azhar University Hospital [Damietta]. A comparison was made during each step of phacoemulsification with and without endoillumination. The post-operative assessment was performed on the first day, at the end of the first week, the first month, and the third month after phacoemulsification by best corrected visual acuity [BCVA], slit-lamp bio-microscopy and intraocular pressure measurement.

Results: The mean age was 68.1 years; 28 patients were females and 26 had operation in the right eye. Capsulorhexis with illumination showed good results among 8 patients, 8 showed no change, and only two patients were worsened. However, without illumination, 16 patients had good results and 6 showed no improvement without any significant difference. In hydrodissection with illumination, 6 had good results and 4 showed no change. But, without illumination, 16 had good results, and 8 showed no improvement. The nucleus fragmentation with illumination revealed excellent results in 24 patients. However, without illumination, two patients had good results, 8 cases showed no improvement, and only two patients were worsened with a significant difference.

Conclusion: Intracameral endoillumination improves the visual quality particularly the step of the nucleus fragmentation during cataract surgery.

Keywords: Intracameral; Endoillumination; Hazy cornea; Phacoemulsification.

INTRODUCTION

Cataract surgery has changed dramatically during the past three decades. Phacoemulsification surgery has been routinely used as a standard method. To achieve excellent results, clear visualization is essential in surgery. However, the visualization is a challenge in patients with corneal opacity [1]. In cases with corneal haze, visualization of intra-ocular structures is difficult, and hence, procedures such as capsulorhexis and phacoemulsification become even more challenging [2]. To overcome the difficult situation in eyes with a poor red reflex, many techniques have been adopted. The suggested solutions include staining the anterior lens capsule with dye and using intracameral endoillumination [3]. So, there is a need for an easy and effective method for improving the red reflex in such difficult situations to improve surgical outcome. Endo-illumination is now frequently used in retinal surgeries to improve the quality of vision during vitreoretinal surgeries and allow a bimanual

approach as a self-supported system [4].

THE AIM OF THE WORK

This work aimed to evaluate the use of endo-illumination systems in phacoemulsification in cases with hazy cornea and to assess its efficacy, complications, and the best way of using it.

PATIENTS AND METHODS

This prospective study included 40 eyes with cataract and hazy cornea, scheduled for cataract surgery. They were selected from Al-Azhar University Hospital [Damietta]. All signed a written consent. The Post-operative assessment was done on the first day, the end of the first week, the first month, and third months after phacoemulsification. At each follow-up visit, best-corrected visual acuity [BCVA] was tested by Snellen equivalent, intraocular pressure [IOP] determined by computerized tonometer [Air puff], slit-lamp examination of the anterior segment by Sun kingdom version to assess corneal edema and anterior segment of the eye. In addition, a non-contact 90D lens [Volk 90D. lens] and slit-lamp biomicroscoy were used to assess retinal changes in patients especially diabetics.

Inclusion criteria: patients with mild to moderate diffuse or localized corneal opacity related to senility and ocular surface disease, and patients with significant cataract confirmed by slit-lamp biomicroscoy were included.

Exclusion criteria: Patients who refuse to share in the study, patients with clear lens, patients with corneal opacity in which endothelial cells were <1600 cells/mm^2 by specular microscopy, patients with a clear cornea, patients with traumatic cataract, patients with subluxated lens, patients with Fuchs' endothelial dystrophy and patients with retinal detachment, were excluded.

Surgical procedure: Dilatation of the pupils was achieved by using tropicamide, cyclopentolate. All operations were done under general or local anesthesia according to the patient age, patient fitness, history of past or present systemic diseases [Three patients were done under general anesthesia and others were completed by local anesthesia]. Local anesthesia was achieved by peribulbar [extraconal] block, using 23G, 25 mm long needle which was inserted through the skin in the inferotemporal quadrant at the junction between the lateral $^1/_3$ and the medial $^2/_3$. Five milliliters of local anesthetic agent [a mixture of 70% lignocaine 2%, 30% bupivacaine 0.5%, and hyaluronidase 10 IU/ml of the mixture] were injected. Complete skin sterilization was achieved by povidone-iodine 10% which had been applied to the skin around the eye. Povidone-iodine 5% was instilled into the conjunctival sac and was also used to paint the skin of the eyelids before draping and left to work for three minutes before washing. Careful draping was then performed, ensuring that the lashes and lid margins were isolated from the surgical field, and a speculum was inserted.

Phacoemulsification with foldable intraocular lens [IOL] implantation: All main steps were done with and without illumination [capsulorhexis, hydrodissection, nucleus fragmentation, irrigation aspiration, and IOL implantation]. A clear corneal port made at 11 o'clock by keratome 2.4 mm. Two side port with MVR blade 20 G at 2, 8 O'clock. And aside port was done at 5 or 6 o'clock for the Endoilluminator by MVR 23 G and through it, we can use the illumination [figure 1A]. The anterior capsulorrhexis was performed after the injection of viscoelastic material [1% sodium hyaluronate] by capsule-rhexis forceps, most of cases was done central 5 to 5.5 mm in diameter, regular and few cases were irregular in shape, after dye staining if need [figure 1B]. Hydrodissection below the anterior capsule-rhexis to separate cortex from lens capsule at many points [figure 1C]. Phacoemulsification was accomplished using a "horizontal chop" maneuver, under injection of viscoelastic material [1% sodium hyaluronate] to cover the endothelial cells. We do a burst mode at first [vacuum 350-400 and 20-30 power] using a chopper to fragment the nucleus into smaller pieces, which makes emulsification as well as aspiration of cortical material easier by pulsed mode [vacuum 250-300 and power [torsional 50-60 and longitudinal 10-20 [figure 1D]. Irrigation/ aspiration [I/A] were used to remove the remaining cortex [figure 1 E]. Injection of the hydrophilic intraocular lens after inflation of the capsular bag with viscoelastic material, [figure 1 F] with the removal of residual viscoelastic material via I/A cannulas. Stromal hydration was performed to all ports to seal the wounds. Topical moxifloxacin and prednisolone eye drops were dropped after the removal of the eye speculum. After the operation, all patients received the same standard medications, consisted of a combination of prednisolone acetate 1% and moxifloxacin 0.5% eye drops started at six times daily with gradual tapering.

Postoperative assessment: The post-operative assessment was completed by best corrected visual acuity [BCVA], slit lamp biomicroscoy using Sun kingdom version to assess corneal edema and

anterior segment of the eye, intraocular pressure [IOP] measurement using Topcon Air puff, and fundus examination by Volk 90D to assess retinal changes especially in diabetics. it was considered only for some selected cases which was taken a long time for procedure to assess endothelial cells count.

Statistical Analysis: The findings were analyzed using SPSS [Statistics Kit of Social Sciences] version 23 [SPSS Inc., Chicago, IL, USA]. The normally distributed data are seen in the mean and standard deviations. Quantitative data were examined by the Kolmogorov-Smirnov data normality test independent sample t-test [student t-test] and U-test [Mann-Whitney U-test] were used for comparison between the two groups. Significant effects were considered when the P-value was less than or equal to 0.05.

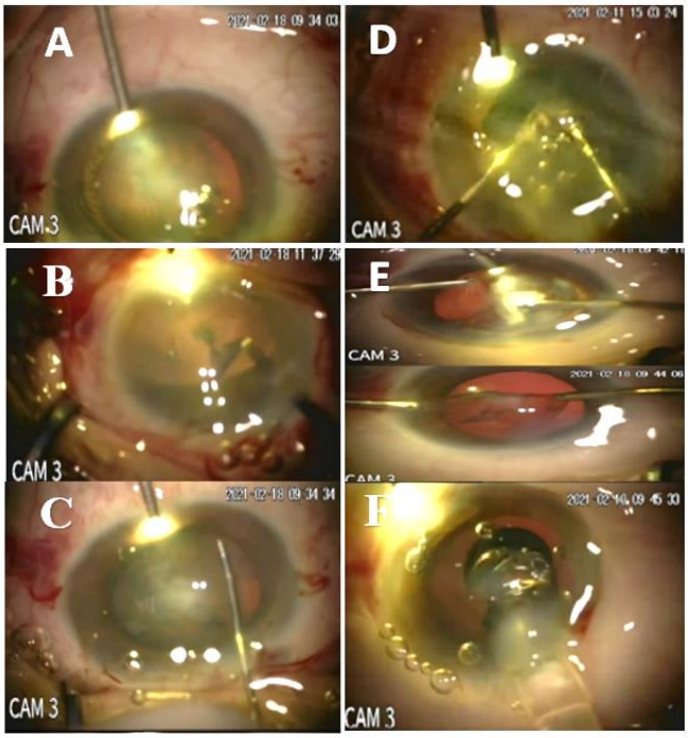

Figure [1]: Steps of phacoemulsification using intracameral endoillumination at 5 o'clock: [A] Introduction of endoillumination at 5 o'clock [B] Capsulorhexis, [C] Hydro-dissection, [D] Nucleus fragmentation, [E] I/A, and [F] IOL implantation

RESULTS

In the present study, the mean age was 68.1 years and ranged from 60 to 82 years. In addition, 28 patients were females and 26 patients were operated on in the right eye [Table 1]. Capsulorhexis with illumination showed good results in 8 cases, 8 showed no change, and only 2 patients were worsened; while without illumination, 16 cases had good results and 6 cases had no enhancement without significant difference. In Hydrodissection with illumination, 6 cases had good results and 4 showed no change; while without illumination, 16 patients had good results, and 8 cases showed no improvement without significant difference. Nucleus fragmentation with illumination showed excellent results among 24 patients; but without illumination, two cases had good results, 8 cases showed no improvement, and only 2 patients were worsened with a significant difference. Also, using illumination showed non-significant differences in [irrigation/aspiration] and IOL implantation [Table 2]. Concerning postoperative visual acuity, mean visual acuity at pre-operative, postoperative first week, first month, and third month were 0.1, 0.2, 0.2, and 0.2, respectively, with a statistically significant improvement after than before surgery. Intra-ocular pressure at pre-operative, first week, first month and third month were 16.9, 16.5, 15.9 and 15 respectively, with a significant difference [Table 3].

Postoperative follow-up of corneal edema revealed that, at the first postoperative day, 18 patients had mild edema, 14 cases had moderate, and 8 cases had severe edema. At the end of the first postoperative week, 34 patients had mild edema and 6 had moderate edema. At the end of the first postoperative month, only two patients had mild edema and at the end of the third postoperative months, no cases of edema [Table 4].

Table [1]: Demographic data and side of operation

		Mean ± SD	Range [minimum-maximum]
Age		68.2±5.5	60-82
Sex	Female	28 [70.0%]	
	Male	12 [30.0%]	
Side	Left	14 [35.0%]	
	Right	26 [65.0%]	

Table [2]: Operative procedure among studied populations

		Worsened	Not enhanced	Limited	Good	Excellent	P- Value
Capsulorhexis	With	2	8	22	8		0.4
	Without		6	18	16		
Hydrodissection	With		4	30	6		0.053
	Without		16	16	8		
Nucleus fragmentation	With			2	14	24	0.001*
	Without	2	8	28	2		
I/A	With	4	10	18	8		0.16
	Without	2	12	26	0		
IOL implantation	With		18	22			0.5
	Without	2	18	18	2		

Table [3]. Visual Acuity and Intra-Ocular Pressure

		Mean	SD	Minimum	Maximum	P value
Visual acuity	**Pre- Operative**	0.1	0.1	0.012	0.170	0.001*
	1st Week	0.2	0.1	0.033	0.250	
	1st month	0.2	0.1	0.100	0.350	
	3rd months	0.2	0.1	0.100	0.350	
Intraocular pressure [mmHg]	**Pre- Operative**	16.9	1.8	13	20	0.023*
	1st Week	16.5	1.7	14	21	
	1st month	15.9	2.3	13	22	
	3rd months	15.0	2.0	11	20	

Table [4]: post-operative corneal edema

	1st day	1st week	1st month	3rd month
No			38[95%]	40[100%]
Mild	18[45%]	34[85%]	2[5%]	
Moderate	14[35%]	6[15%]		
Severe	8[20%]			

DISCUSSION

This study included 40 eyes having cataract with hazy cornea. The mean age was 68.1 years (ranged from 60 to 82 years). Yun *et al.* [5] studied 17 eyes with the mean age of the patients was 63.7 years [range 48 to 84 years]. Also, Yuksel [1] studied 12 patients with corneal opacity. The mean age of patients was 64.2 ± 15.3 years [range 40 to 87 years]. The slight differences between studies could be explained by different sample size.

In the present study, there was a little improvement in the visualization of the anterior lens capsule compared to trypan blue, after trypan blue capsulorhexis with illumination or without illumination. Similarly, Yepez *et al.* [6] studied 20 eyes with senile cataract and co-existing corneal haze and showed that there was only some improvement in the visualization of the anterior capsule. But there was excellent improvement of other steps. Results also agree with Narumichi *et al.* [7] who noted that using of trypan blue enhanced clarity of the anterior lens capsule, and a capsulorhexis could be completed in all cases. Rakhi *et al.* [8] reported that many techniques for enhancing the anterior capsule visualization have been adopted. The dye-assisted cataract surgery improves the visibility of the anterior capsule, but not enough for finishing the subsequent steps. Chung *et al.* [9] reported that both trypan blue 1% is safe and effective for visualization of the anterior capsule during cataract surgery with co-existing corneal opacity and mature cataract.

Bhartiya *et al.*[10] reported that trypan blue enhances the visibility of the anterior capsule in cataract surgery with hazy cornea. Melles *et al.* [11] used trypan blue to stain the anterior lens capsule during capsulorhexis in dense cataract with dim red reflex. Van Dooren *et al.* [12] reported that trypan blue 0.06% has no adverse effects on the

corneal endothelium during cataract surgery.

In the present study, there was an excellent enhancement of the nucleus fragmentation with illumination. Similarly, Yepez *et al.* [6] studied 20 eyes with senile cataract associated with corneal haze and showed that there was an excellent enhancement in the visualization of lens structure during nucleus fragmentation. Nishimura *et al.* [13] used an endoilluminator as an additional light source inside the anterior chamber during phaco-emulsification in an eye with hazy cornea. So, a red fundus reflex can be improved, and the lens structures are visible. Also, in the present study using the endo-illumination was insignificant in [irrigation/ aspiration] and IOL implantation. These results agree with Yun *et al.* [5] who studied 17 eyes and showed only helpful visualization in only 4 eyes out of 17 eyes and noted that endoillumination assisted phacoemulsification was not significant in the steps of I/A or IOL implantation.

In the present study, there was an improvement of visual acuity after than before surgery, which persisted till the end of follow up time. Panda *et al*. [14] reported that phacoemulsification with trypan blue enhanced visual acuity from less than 0.2 to 0.32. Ho *et al*. [15] reported that the pre-operative mean UCVA and BCVA were 0.025 and 0.032, which significantly increased to 0.1 and 0.13, respectively after surgery. 92.4% had better visual acuity after than before surgery. The visual outcome was enhanced for at least two lines except one eye was worsened.

Corneal edema was found in two eyes and reactivation of other corneal pathology in four eyes. Prafulla *et al*. [16] reported that the use of 0.1% trypan blue with traditional coaxial illumination alone has been adopted as a safe and effective manner to improve visibility for cataract surgery associated with corneal opacities, although in some patients staining alone may not give accepted visualization. Sharma *et al*. [4] reported that, the penetrating keratoplasty [PKP] combined with cataract surgery is a surgical choice for patients with corneal opacity with dense cataract. Although it is very difficult to survive cornea with deep vascularization, that may cause corneal haze. In addition, this procedure may be followed by serious complications as expulsive hemorrhage and late rehabilitation in comparison to cataract surgery alone. Yokokura *et al.* [17] reported that chandelier illumination was provided a better effect for triple procedure penetrating keratoplasty.

In the present work, intracameral endo-illumination was shown to improve visibility and reduce scattering in patients with corneal haze. In agreement with that, Srinivasan *et al.* [18] stated that intracameral light source has less retinal phototoxic in comparison to the chandelier light, which illuminates directly to photoreceptors. Also, Yepez *et al*. [6] reported that coaxial illumination from the microscope during conventional phaco-emulsification didn't provided perception of intraocular structure but the depth of field, which increase in lateral illumination oblique endo-illumination by using through the anterior chamber improves depth perception and perfect visibility of lens structures and posterior capsule as well as lowering the risk of complication. Oshima *et al.* [19] reported that chandelier reteroillumination assisted phacoemulsification in patients with corneal opacity.

As the surgeon can use both hands free because of the self-retaining illumination, this provides the surgeon to perform phacoemulsification easily, whereas the distance between the intracameral endoilluminator and the retina is at least 15.0 mm in and this distance is longer than 3.5 mm for the retro-illumination which may cause retinal phototoxicity.

Yokokura *et al.* [17] studied seventeen eyes, divided into two groups a chandelier group and a non-chandelier group. In the chandelier group, the time of procedure and the rate of successful capsulorhexis had respectable results than in the non-chandelier group. The rates of capsular tear and successful IOL implantation had no significant difference. Kendall *et al.* [20] studied femtosecond laser-assisted cataract surgery [FLACS] reported that it had a longer time than conventional phacoemulsification. FLACS considers a Quantum leap of clinical and financial challenges to the cataract surgeon. In a survey performed by Dalton [21] and involved 1047 ophthalmologists, 72% reported that financial problems were their most important factor in using this Quantum leap. Patient dissatisfaction and increased patient ambitions were also reported.

In the present study, there was no reported complication (e.g., Descemet tear or thermal corneal injury). However, postoperative corneal edema was mild among 18 cases, moderate among 14 cases and 8 had severe edema at the first postoperative day, that subsides with time and at the end of the third postoperative month, no edema was reported. Similarly, Yuksel [1] noted that there were no complications after cataract surgery with endo-illumination. However, some surgeons fear to use intracameral endoilluminator to avoid the possible

risk of Descemet detachment and prefer transcorneal illumination for cataract surgery associated with corneal haze.

Conclusion: Intracameral endoilluminator-assisted phacoemulsification was noted to be respectable and easily applicable for surgery in cataracts with corneal opacity. The endoillumination provided higher visibility of lens content. It minimized the risk of loss of endothelial cells. In addition, this technique can reduce the intraoperative risk of complications such as rupture of the posterior capsule, Descemet detachment, and expulsive hemorrhage. Finally, it reduced the expected post-operative corneal edema.

Financial and Non-financial Relationships and Activities of Interest

None

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