Original Article

Demographic Profile, Associated Difficulties and Visual Outcomes of Phacoemulsification in Eyes with White Cataract

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ABSTRACT

Aim: To evaluate the demographic profiles of the patients, associated problems and visual outcomes of phacoemulsification in eyes with white cataract.

Design: A prospective interventional study.

Materials & Methods: A total 76 cases were selected who underwent phacoemulsification cataract surgery with mature and hyper-mature state. This study was done in cataract clinic at Chittagong Eye Infirmary and Training Complex from 1st January 2019 to 31st December 2019. Related all pre and post-operative data were recorded according to the protocol of cataract clinic of this hospital. All surgeries were done under peri-bulbar anesthesia. Two plane clear corneal incision measuring 3.2 mm at superior limbus was done in every patient by a keratome and a Side port entry at 2 O'clock position was made by a 15° knife. Trypan blue 0.1% was used in all patients for staining of anterior lens capsule. A small 'can-opener capsulotomy' was done to release intra-lenticular pressure and or release liquid milky cortical matter. Then a 5-6 mm continuous curvilinear capsulorhexis was done by using Mcpherson forceps. Stop and chop of nucleus was done. All intraocular lenses (IOLs) were implanted in capsular bag. Post operatively patients were treated with topical corticosteroid six times daily approximately four weeks then tapered, topical antibiotic four times daily for one week and topical cycloplegic once daily for two weeks. All patients were followed up on 1st post-operative day, 7th postoperative day, one month and 3 months. Statistical analysis of relevant data was done by using SPSS 16 software.

Results: Mean age was 55.28 ± 9.72 years (ranged 32 to 75 years). Forty one percent patients belonged to 51-60 years. Among different occupations, a significant number of patients (43.42%) were housewives and 64.47% patients came from rural areas. About 67% patients were presented with different systemic diseases (diabetes, hypertension, ischemic heart disease, asthma etc.). Preoperatively about 60% patients was mature type of cataract and remaining was hyper-mature cataract. Intraocular lens power range was +18.00 to +25.50 diopter and mean phaco-time was 0.27 ± 0.11 minutes. Superior clear corneal incision didn't cause statistically astigmatic change post-operatively. The final best corrected acuity in good category (6/6 to 6/18) achieved in 98.70%. Continuous capsulorhexis was the most difficult stage during surgery and doing a small central 'can-opener capsulotomy' to release the intra-lenticular pressure and liquid cortical milk followed by caplulorhexis dramatically reduce the peripheral extension as well as 'Argentina flag sign'. Ninety two percent patients showed no associated complications.

Conclusion: By making good capsulorhexis with the use of trypan blue and two step procedure that is initial small 'can-opener capsulotomy' which reduces the intralenticular pressure followed by an appropriate capsulorhexis make the surgery safer and good visual outcome.

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Keywords: Phacoemulsification, White mature cataract, Hyper-mature cataract, With the rule astigmatism, Against the rule astigmatism, Intraocular lenses, Continuous curvilinear capsulorhexis.

Introduction

Cataract is the most common reversible blindness in the world. White, mature, senile cataract is an advanced form of cataract disease[1]. A cataract is termed white and mature if the cortex and nucleus become so opaque that the red fundus reflex is absent, the cortex becomes extensively hydrated; this is the stage where the lens looks white. In developing countries white mature cataracts are seen very frequently[2,3]. White cataracts may be divided into three types: 1) cortically mature cataract, which has diffusely flocculent cortex and may be associated with increased intra-lenticular pressure (intumescent, swollen cataract); 2) cortically mature cataract with flocculent cortex and a hard, brown nucleus; and 3) uniformly soft cataract with gelatinous cortex and soft nucleus[1]. Phacoemulsification of white mature cataract with posterior chamber intraocular lens implantation may associated with higher rate of complications such as difficulty in capsulorhexis due to fragile capsule, leakage of liquefied cortical material and the absence of red reflex obscure visualization, and capsulorhexis tear tends to extend to periphery because of high intra-capsular pressure[2,3]. The anterior capsule may undergo degeneration with deposition of calcium or development of focal plaques may interfere with the capsulorhexis. Even for the experienced surgeon the harder nucleus will require a longer time and higher power of phacoemulsification. A plaque or residual posterior capsule opacification is observed despite successful surgery. Thus, surgical removal of white mature cataracts presents special challenges to the surgeon[2,3]. In the present study, we were trying to find out the demographic profiles of the patients, associated surgical difficulties & complications and visual outcome of phacoemulsi -fication in white mature cataract.

Material and Methods

This interventional prospective study was done at Chittagong Eye Infirmary and Training Complex (CEITC), from 01.01.2019 to 31.12.2019 (1 year). A total 76 cases were selected for surgery. All surgeries were done by the one qualified phaco-surgeon of the cataract clinic of CEITC.

Inclusion criteria were senile age related white cataract lack of red fundus reflex including mature (including intumescent) and hypermature (including morgagnian and sclerotic) cataract. B-scan ultrasonography was done in all patients to see position of retina and vitreous. Complicated cataract, traumatic cataract, secondary cataract, pseudoexfoliation syndrome, subluxated lens, cataract with corneal opacities, abnormal pupil, posterior segment disease like vitreous opacity, high myopia or any other retinopathy and glaucoma causing functional impairment of vision were excluded from this study. Related all pre and post-operative data were recorded according to the protocol of the hospital. SRK-T formula was used for intraocular lens power calculation.

Surgical procedure

Tropicamide 0.8% and phenylephrine hydrochloride 5% ophthalmic topical drops were used for mydriasis. All surgeries were done under peri-bulbar anesthesia. Two step clear corneal tunnel incision was made at superior cornea near limbus with 3.20 mm keratome and a side port incision at 2.00 O'clock position was made with a 15° knife. Anterior capsule was stained with 0.1% trypan blue. Two percent hydroxypropyle methylcellulose is introduced into anterior chamber. Two step anterior capsulotomy was done to avoid peripheral extension or to prevent 'Argentina flag sign'. First a small 'canopener' capsulotomy with multiple strokes with capsulotomy needle was made with a 27 gauge needle. Liquid cortical material was aspirated with Simcoe cannula. Approximately 5 mm continuous curvilinear capsulorhexis was performed by grasping the capsular tag with Mcpherson forceps and tear the capsule in the curvilinear manner. Fibrosed and calcified areas of capsule was cut by Venus scissor. Gentle hydro-dissection was made in intumescent mature cataract and the nucleus was rotated with anterior chamber cannula. Hydro-dissection was avoided in morgagnian and sclerotic cataract. Phacoemulsification of the nucleus was performed using the stop-and-chop or direct chop technique at iris plane. Maximum torsional power

was set to 100%, vacuum 400 mm H_2O, and inflow 40 ml/min. Cortical remnants were removed by two way Simcoe cannula. Half cc. subconjunctival injection of dexamethasone (5mg/ml) and gentamicin (40mg/ml) was given to all patient at superior conjunctiva.

Post-operatively patients were treated with topical corticosteroid six times daily approximately four weeks then tapered, topical antibiotic four times daily for one week and topical cycloplegic once daily for two weeks. Doses and duration of topical corticosteroid was increased according to post-operative inflammation. All patients were followed up on 1st post-operative day, 7th post-operative day, 1 month and 3 months. Visual acuity was assessed using Snellen's charts in each follow up. Refraction (BCVA) and keratometry was done at final follow-up to detect post-operative astigmatism. Visual outcome (best corrected visual acuity-BCVA) was categorized using the World Health Organization[4] (W.H.O) standard where good vision is 6/6 to 6/18, borderline vision is less than 6/18 to 6/60 and poor vision is less than 6/60. Post-operative astigmatism was expressed as the power of the cylinder lens needed for best correction. All cylindrical lens power; pre and post-operatively was converted into minus and categorized as "acceptable astigmatism (mild)" (0 to ≤ 0.50 DCyl) as this range would not hamper the patient's vision, "moderate astigmatism" (> 0.50 to ≤ 1.50 DCyl) and "large astigmatism" (>1.50 DCyl)[5]. Internationally accepted post-operative corneal astigmatism is 0.50D[5,6]. Statistical analysis of relevant data were done by using SPSS 16 software. A 'p' value of <0.05 was considered significant.

Results

Mean ages was 55.28 ± 9.72 years (ranged 32 to 75 years). The most of the patients belonged to 51-60 years [figure 01]. Around 52.63% (n-40) patients were male [figure 02]. Out of different occupation, there is a large percentage (43.42%) who were housewives [figure 03]. Around 64.47% patients came from rural areas [figure 04] and most of the patients (86.84%) came from average socio economic condition [figure 05].

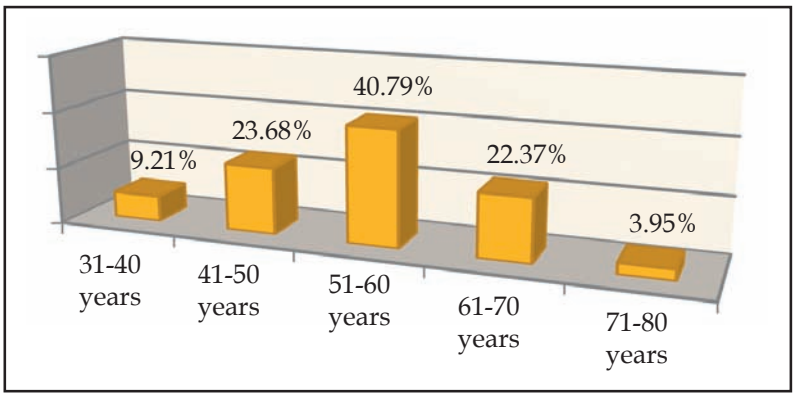


Figure-01: Age distribution of patients.

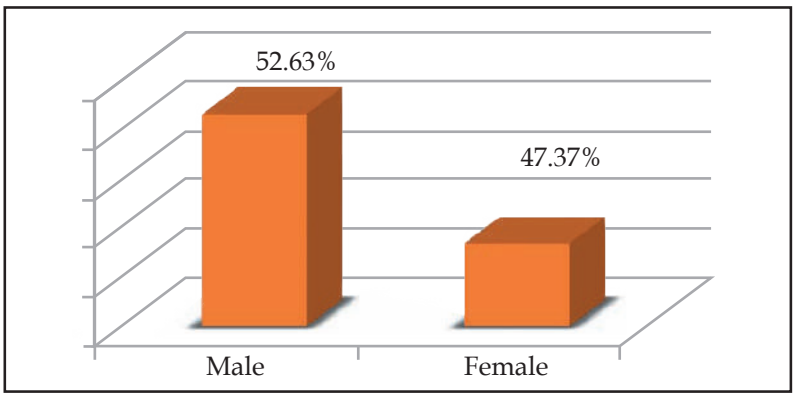


Figure-02: Gender distribution of patients.

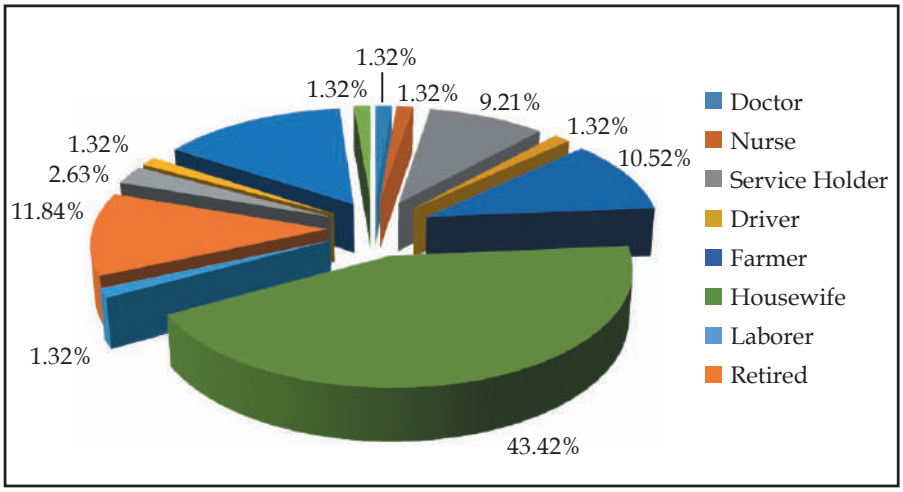


Figure-03: Distribution of occupation.

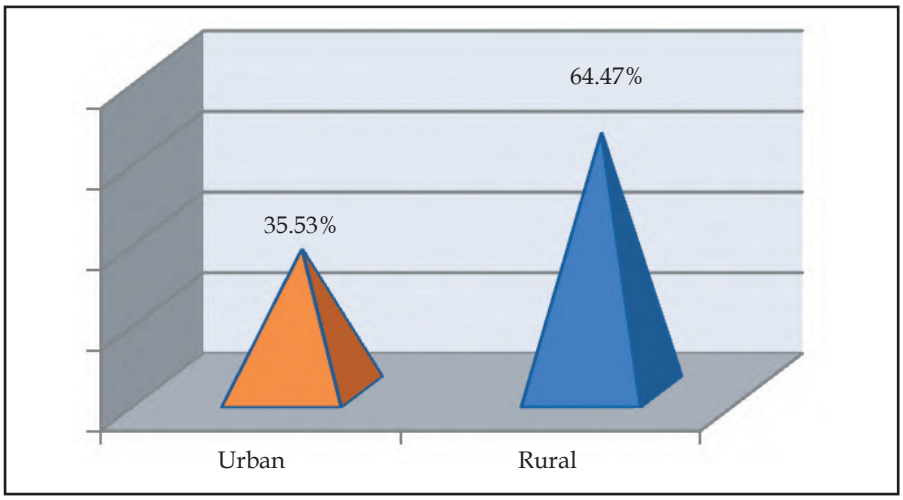


Figure-04: Distribution of resident of the patients.

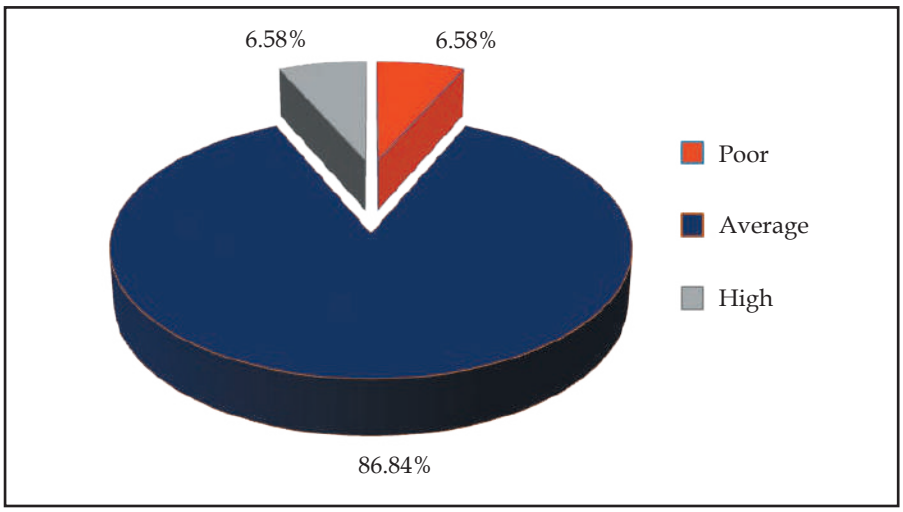


Figure-05: Socio economic condition.

About sixty seven percent (n-51) patients were presented with different systemic diseases. Twenty six percent (n-20) patients have both hypertension and diabetes. Hypertension was the most common, found in 47% (n-36) of patients [table 01].

Table-01: Associated systemic diseases.

Systemic disease	Frequency	Percent
HTN	09	11.80%
HTN/IHD	03	3.90%
HTN/DM	20	26.30%
HTN/DM/IHD	02	2.60%
HTN/Asthma	02	2.60%
DM/Asthma	01	1.30%
DM	08	10.50%
Asthma	05	6.60%
IHD	01	1.30%
No systemic association	25	32.90%
TOTAL	76	100%

Note: HTN=Hypertension, IHD= Ischemic heart disease, DM= Diabetes mellitus

Pre-operatively, about 60% patients (n-46) had finger counting vision, 25% (n-19) had PL vision and 14.5% (n-11) had hand movement vision [table 02]. 68.42% patients (n-52) presented with mature cataract and remaining 31.58% (n-27) were hyper-mature. Out of hyper-mature cataract 22.37% (n-17) were Morgagnian type and 9.21% (n-7) were sclerotic [figure 06].

Table-02:Pre-operatively visual acuity.

Pre-operative VA	Frequency	Percent
FC	46	60.50%
HM	11	14.50%
PL	19	25%
Total	76	100%

Note: VA= Visual acuity, FC= Finger counting; HM= Hand Movement; PL= Perception of Light

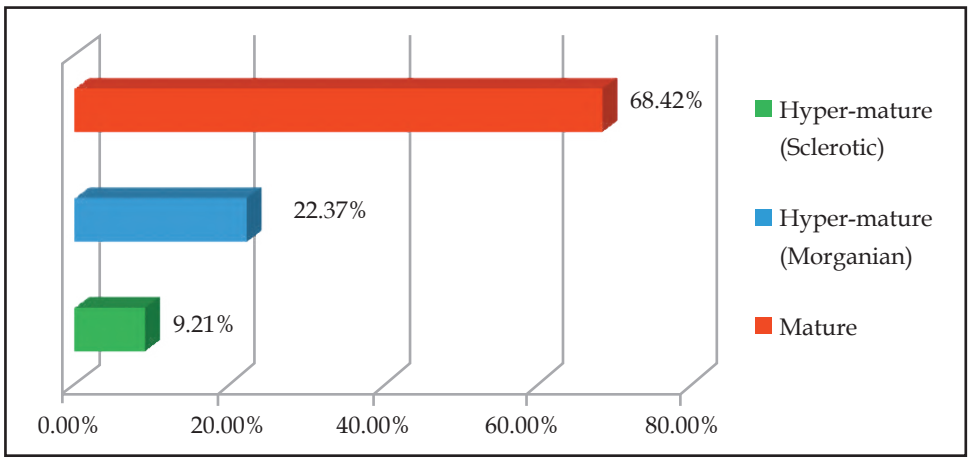


Figure-06: Types of cataract.

Mean IOL power was 21.57 ± 1.70 diopter (range 18-25.5 diopter). About 83% (n-63) patients have had their IOL power range in 20-24 diopter. Mean phaco-time was 0.27 ± 0.11 minutes (range 0.08-0.48 min)

In the study group, pre-operative 'with the rule astigmatism'(WTR)was 47.36% (n-36), 'against the rule astigmatism' (ATR) was 50% (n-38) and 'no astigmatism' (NO) was 2.64% (n-02), whereas post-operatively'with the rule astigmatism' reduced to 36.84% (n-28), 'against the rule astigmatism' became increased to 61.84% (n-47) and 'no astigmatism' reduced to 1.32% (n-1) [table 03].

Table-03: Distribution of pre and post-operative rule astigmatism.

Pre-operative Astigmatism	Post- Operative Astigmatism			Total n (%)
	With the rule n (%)	Against the rule n (%)	No n(%)	
With the rule	23 (30.26%)	13 (17.11%)	0 (0.00%)	36 (47.36%)
Against the rule	5 (6.58%)	33 (43.42%)	0 (0.00%)	38 (50.00%)
No Astigmatism	0 (0.00%)	01 (1.32%)	01 (1.32%)	02 (2.64%)
Total	28 (36.84%)	47(61.84%)	01(1.32%)	76(100%)
(x^2=58.41; Cramer's V= 0.620; df=4; p= 0.00 (p< 0.05)				

**Note: WTR- With the rule Astigmatism, ATR- Against the rule Astigmatism, NO- No Astigmatism.

Among WTR astigmatism group (47.36%), 30.26% remained at the same group and about 17.11% (n-13) turn to ATR astigmatism after surgery. Among 50% (n-38) cases of pre-operative ATR astigmatism, post-operatively more than 43.42% (n-33) remained at the same group while only 6.58% (n-5) turned over to the group of WTR. About 2.64% (n-2) cases presented preoperatively at the group of "no astigmatism", one of them (1.32%) remained in "no astigmatism" and one of them (1.32%) changed into ATR astigmatism group post-operatively [table 03]. The changes among the pre- and post-operative rule astigmatism statistically are negligible (p< 0.05).

In comparison between the mild/acceptable, moderate and large groups of astigmatism there is no statistically significant change observed between the pre-operative and post-operative status of the cases (p<0.05). In the group of "Acceptable" astigmatism, the pre-operative cases were 52.63% where as in the post-operative cases percentage was same. In "Moderate" group, the number decreased from 44.74% to 40.79% and the increasing tendency was for the "Large" group where post-operative cases were increased from 2.63% to 6.58%. [Table 04].

Table-04:Comparison of pre- and post-operative astigmatic change.

Astigmatism (Diopter)	Pre-operative		Post-operative		'p' value
With the rule	N	%	N	%	0.00
Against the rule	40	52.63%	40	52.63%	
No Astigmatism	34	44.74%	31	40.79%	
Total	02	2.63%	5	6.58%	
	100	100%	100	100%	
(x^2=42.18; Cramer's V= 0.430; df=9;p= 0.00 (p< 0.05)					

Table-05: Postoperative visual acuity

VA	1st day (unaided)	3 month (unaided)	3 month (BCVS)	WHO standard
6/6 to 6/18 (Good)	94.70%	93.40%	98.70%	>80%
6/24 to 6/60 (Borderline)	5.30%	6.60%	1.30%	<15%
< 6/60 (Poor)	00.00%	00.00%	00.00%	<5%
TOTAL	100%	100%	100%	100%

Note: VA- Visual Acuity, BCVS-Best Corrected Visual Acuity.

It was observed, first post-operatively unaided visual acuity was good in 94.70% patients and it was dropped to 93.40% after 3 months follow up. The final best corrected acuity in good category achieved in 98.70% ($p<0.05$). [figure7,8; table 05].

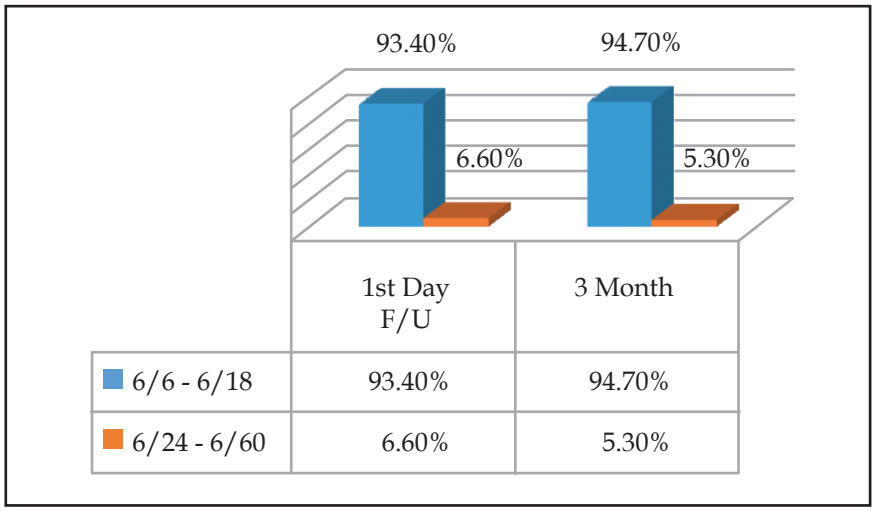


Figure-07: Post-operative unaided visual acuity

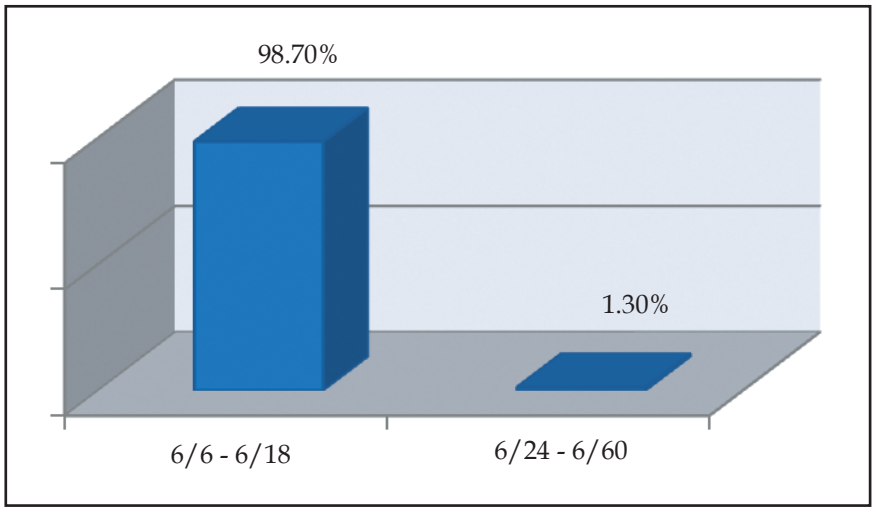


Figure-08: Final best corrected visual acuity (BCVA)

Majority of patients (63.12%, n-48) achieved post-operative final refraction of <-1.00 to -0.12 diopter spherical equivalent. Emmetropia was achieved in 26.32% (n-20) patients [figure 09].

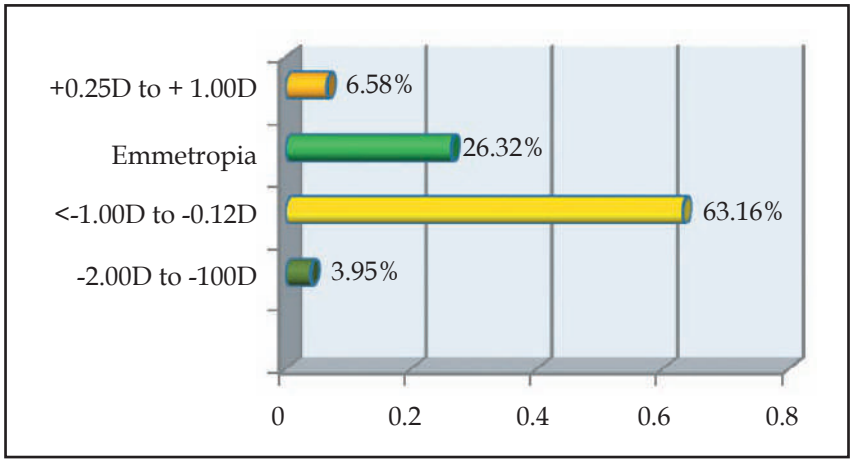
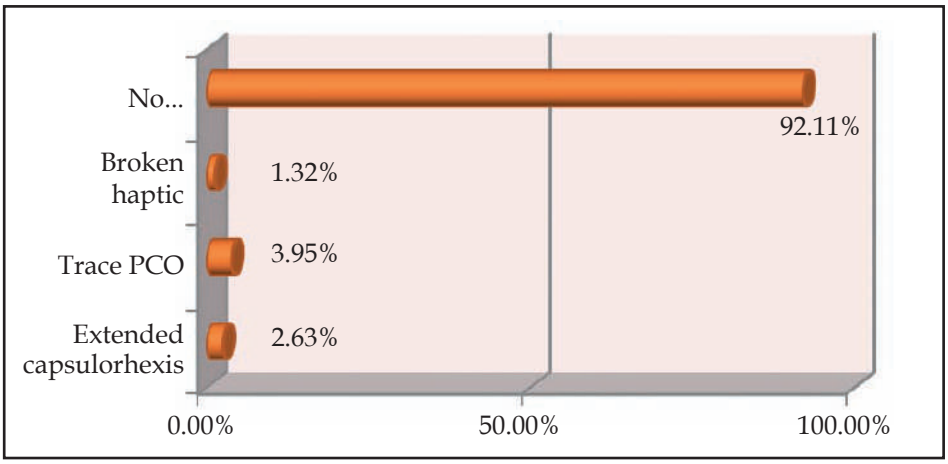


Figure-09: Post-operative spherical equivalent.

About 92% (n-70) patients showed no associated complications, capsulorhexis extended in 2.63% (n-2) patients and there were trace posterior capsular opacification in about 4% (n-3) patients. In one patient, one haptic of intraocular lens was broken during implantation which was replaced at the same time of surgery [figure 10].Postoperatively no patients developed secondary glaucoma.



Note: PCO - posterior capsular opacification

Figure-10: Complications of surgery.

Discussion

Phacoemulsification of white cataracts is associated with some difficulties and a higher rate of intra-operative complications. White mature cataract is so opaque that the red fundus reflex is absent. To perform successful continuous curvilinear capsulorhexis, the surgeon can use different dyes for staining the anterior capsule for contrast enhancement. Anterior capsular staining can be performed with 0.1% trypan blue, 0.5% indocyanine green (ICG), 0.05% gentian violet, 2% fluorescein sodium and autologous blood.

Several studies showed the use of these dyes to be safe and effective, and trypan blue, ICG and gentian violet are more effective in staining the capsule[6,7,8,9]. In our all cases, we used 0.1% trypan blue for doing capsulorrhexis. Making a continuous curvilinear capsulorrhexis in white cataracts it is more challenging due to fragile and calcified and fibrosed capsule, leakage of the liquefied cortical material obscure visualization, high intra-lenticular pressure which leads to capsulorhexis tear to the periphery. Here we used

a different technique for doing capsulorhexis to avoid peripheral extension or to prevent 'Argentina flag sign'. First a small CCC or small can-opener capsulotomy with multiple strokes with capsulotomy needle was made with a 27 gauge needle. Liquid cortical material was aspirate with Simcoe cannula. Approximately 5 mm continuous curvilinear capsulorrhexis was performed by grasping the capsular tag with Mcpherson forceps and tear the capsule in the curvilinear manner. Fibrosed and calcium deposited areas of capsule was cut by Venus scissor. We avoided hydro-dissection in morgagnian and sclerotic cataract and did gently in mature white cataract. Gentle hydro-dissection in different quadrant and slight repeatedly tapping pressure over the nucleus facilitates nuclear separation and rotation, although hydro-dissection is not so important in cases of white cataracts[2]. Phacoemulsification of the nucleus was performed using the stop-and-choptechnique at iris plane[11]. Maximum torsional power was set to 100%, vacuum 400 mm H_2O, and inflow 40 ml/min. In our cases, 91% nucleus were grade-2, small and fragile, 9% were grade-3 nucleus. Hard nucleus needed increased phacoemulsification energy which may causes corneal endothelial loss leading to corneal edema. Here we used 100 torsional phaco power but did not use any longitudinal phaco power. Our mean phaco time was 0.27 ± 0.11 minutes (0.08 to 0.48 min). None of our case developed postoperative corneal edema.

One studies showed that incision through either temporal clear cornea or superior scleral tunnel in phacoemulcification shows no statistic difference in astigmatism change on keratometry 3-month postop[12]. Other study showed temporal clear corneal incision is evidently better than superior clear corneal incision as far as surgically induced astigmatism is concerned[13]. In our study it is observed that clear corneal incision at superior limbus showed no statistically significant change in surgically induced astigmatism post-operatively ($p<0.05$). Apart from surgically induced astigmatism it was observed, first postoperative unaided visual acuity was good in 94.70% patients and it was dropped to 93.40% after 3 months follow up but the final best corrected acuity in good category was 98.70% ($p<0.05$). Presence of hard nucleus where lens fibers are very cohesive thus making division difficult,[14] thin posterior capsule and stretched by expanded intumescent lens and also flaccid with wrinkles and a laxity that makes it prone to be ruptured during phacoemulsification particularly during nuclear fragment consumption stage. The problem is worsened by the absence of any epinucleus that protects the posterior capsule. White cataracts in our study were usually brittle and not very hard. 90% were grade-2 and they were safely divided and emulsified and 09% were grade-3 where leathery fibers kept most of the nucleus joined. However, no patients were complicated with posterior capsular rupture as well as nuclear drop.

Small capsulorhexis was reported to lead to capsule contraction[15,16]. Capsular fibrosis was reported to occur in 12% of eyes with white mature cataracts, all of which had a capsulorhexis diameter of less than 5 mm[3,16]. In our study we did not found any capsular fibrosis within 3 months follow up period. Our all capsulorhexis size was 5.5-6 mm. In our study, intra-operatively posterior capsular plaque or opacity was found in 3.95% of the patients. Studies reported this ratio as 27.3% and 33%[3,17]. This difference may be related to the prolonged waited time for the surgery. In developing countries white mature cataracts may constitute a significant proportion of the patients with cataract[18]. Here we observed 43.42% of our patients were housewives and this large portion may have lack of awareness or may have less care in their family. Most of the patients (64.47%) came from rural areas and 86.84% have average socioeconomic condition may have lack of awareness.

Conclusion

Although intra-operative complications of phacoemulsification of white mature cataract is high, a successful continuous curvilinear capsulorrhexis can be done with use of trypan blue and two step procedure that is initial small canopener capsulotomy which reduces the intra-lenticular pressure followed by an appropriate capsulorhexis make the surgery safer and good visual outcome.

Limitations

1. No pre and post-operative study of corneal endothelium.
2. Not measured anterior chamber depth change.
3. Not measured the central corneal thickness changes.

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Conflicts of interest : There are no conflicts of interest.

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