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STUDY OF CUMULATIVE DISSIPATED ENERGY USING VARIOUS PHACO TIPS IN PHACOEMULSIFICATION SURGERY OF CATARACT- A PROSPECTIVE RANDOMIZED INTERVENTIONAL STUDY

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Abstract

Background: Phacoemulsification surgery is being increasingly used as a method of choice in developing countries for cataract. It can be done by different methods viz. phaco chop technique and divide and conquer technique. Cumulative dissipated energy (CDE) is used to monitor the energy delivered during the process of cataract surgery by phacoemulsification process. The less is the CDE, better is the corneal impact. Different phaco tips used in phacoemulsification are in the range of 0 to 45 degree as 0,15,30,45. We conducted a prospective interventional study to evaluate effectiveness of different phaco tips in various grades of cataract and its impact on cornea, effective phaco time and intraoperative complications in cataract surgery.

Patients and methods: This was a prospective interventional study in patients with age related cataract visiting a tertiary care hospital during a period of 1year. Patients aging more than 40 years having cataract were randomly divided in three groups. Group A (n=72), Group B (n=72) and Group C (n=72). Group A was operated using 0 degree phaco tip, Group B using 30 degree phaco tip and Group C using 45 degree phaco tip. Intraoperative effective phaco time (EPT), cumulative dissipated energy (CDE) and complications were noted in each group. Postoperatively patients were examined on Day 1, Day 7, Day 30, Day 45 and 6 months for best corrected visual acuity and status of cornea.

Results: 216 patients were included in the study which were randomly allocated Group A (n=72), Group B (n=72) and Group C (n=72). All the three groups were comparable with respect to age and gender ($z= 0$, $p> 0.05$). Mean EPT for 0 degree Phaco tip was 41.08 ± 9.3 sec, for 30 degrees was 43.38 ± 13.76 sec and for 45 degrees was 54.80 ± 19.83 sec. There was no statistically significant difference in the mean EPT of the patient who underwent phaco surgery using 0 and 30 degree phaco tips (z test= 1.42 and p value = 0.11.), however there was a statistically significantly difference in mean EPT, for 30 and 45 degrees (z test= 5.2 and p value =0.02.) and 0 and 45 degree phaco tips (z test= 9.2 and p value = 0.02). Mean CDE comparison between 0 and 30 degree tips was not statistically significant, however there was a statistically significantly difference in mean CDE, for 30 and 45 degrees (z test= 4.28 and p value = 0.01) and 0 and 45 degree phaco tips (z test=8.71, p value>0.01) operated patients of cataract. Most common intra operative complication was posterior capsular rent seen in 2.7 % of 0 degree phaco tip while 5.5% of 30 degrees and 5.5% of 45 degrees. Post operatively on Day 7, visual outcome depending on logMAR scale > 1 was41.6% in group A and 50% in group B ($z= 1.98$, $p< 0.05$). Similarly, on Day 7, clear cornea was seen in 61.1% group A and 33.3% in group B ($z=2.0$, $p< 0.05$).

Conclusions: We concluded that 0 degree tip was having similar visual outcome as 30 degree while both 0 and 30 degree had better visual outcome than 45 degree however and no difference was found in final best corrected visual acuity between 0, 30 and 45 degree phaco tip. It was also observed that 0-degree phaco tip was associated with decreased corneal damage as compared to 30 degree phaco tip and 30 degree with decreased damage than 45 degree phaco tip however, it did not affect final visual outcome. 0, 30 and 45 degree phaco tip was associated with same incidence of post-operative complication and it did not affect visual outcome. Also, Effective phaco time and Cumulative dissipated energy was similar in 0 degree tip compared to 30 degree tip and less in 30 than 45 degree phaco tip.

Keywords: BCVA (Best corrected visual acuity), EPT (Effective phaco time), NS(Nuclear sclerosis) , DM(Descemet's membrane)

Introduction

Cataract is the commonest cause of avoidable blindness worldwide[1] and cataract surgery is the commonest procedure performed in ophthalmology[2]. Cataract surgery have changed significantly over the past several decades from Intracapsular cataract extraction (ICCE), Conventional Extracapsular cataract extraction (ECCE) to Small incision cataract surgery (SICS) and finally to more advanced Phacoemulsification which is now considered as the gold standard for cataract surgery[3].

Phacoemulsification is a technique of cataract surgery in which ultrasonic device is used to break and then remove the cloudy lens and implant the artificial intraocular lens to improve the vision. The goal of emulsification of lens is to

remove the cataractous lens with small incision. Cumulative dissipated energy (CDE) is used to monitor the energy delivered during the process of cataract surgery by phacoemulsification process. The less is the CDE, better is the corneal implant[4]. Different phaco tips used in phacoemulsification are in the range of 0 to 45 degree as 0,15,30,45.

Complications of phaco surgery include Descemets membrane tear, Corneal edema, Corneal endothelial damage, Posterior displacement of iris, lens diaphragm, deepening of anterior chamber and pupillary dilatation and astigmatism due to faulty incision closure[6]. The purpose of this study is to find out which phacoemulsification tip requires less CDE and better visual rehabilitation.

Objective

Objective of the study was to evaluate CDE using various phaco tips in phacoemulsification of cataract surgery, its impact on cornea, effective phaco time and intraoperative complications in cataract surgery.

Study Design

This is a prospective interventional study in patients with age related cataract visiting a tertiary care hospital during a period of one month. Only patients more than 40 years of age of either sex were included in the study. Patients with preexisting corneal opacity, corneal dystrophy, corneal degeneration, pterygium, uveitisor posterior segment pathology like diabetic retinopathy, maculopathy, optic neuropathy, retinal detachment were excluded from the study. Patients less than 40 years or having glaucoma, complicated cataract or phacodonesis were also excluded from the study. Finally, 216 patients were included in the study which were randomly allocated to three different groups: Group A (n=72), Group B (n=72) and Group C (n=72). Group A was operated using 0 degree phaco tip, Group B using 30 degree phaco tip and Group C using 45 degree phaco tip. Intraoperative effective phaco time (EPT), cumulative dissipated energy (CDE) and complications were noted in each group. Postoperatively patients were examined on Day 1, Day 7, Day 30, Day 45 and 6 months for best corrected visual acuity and status of cornea. All the surgeries were performed by single surgeon. The technique of phacoemulsification surgery was phaco chop method[5].

Results

The mean age of pts operated with 0 degree phaco tip was 69.05 years, for 30 degrees was 66.69 years and for 45 degrees was 62.63± years ($z < 1.96$, $p > 0.05$). Gender-wise mean age of the patients in group A, B and C were comparable and there were no statistically significant differences **(Figure 1)**.

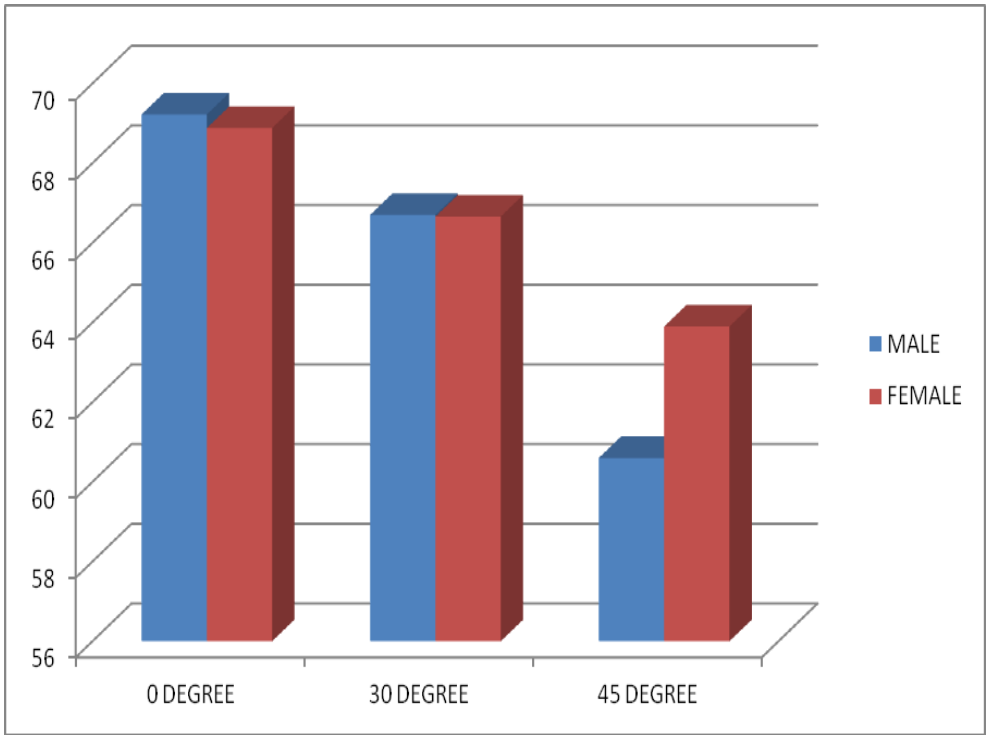

Figure 1: Mean age for Phaco tips

Mean EPT for 0 degree Phaco tip was 41.08 ± 9.3 sec, for 30 degrees was 43.38 ± 13.76 sec and for 45 degrees was 54.80 ± 19.83 sec **(Table 1)**.

Table 1: Mean Effective Phaco Time for Phaco tips

Phaco tips	0 degree	30 degree	45 degree
Mean EPT	41.08 ± 9.3 sec	43.38 ± 13.76 sec	54.80 ± 19.83 sec

There was no statistically significant difference in the mean EPT of the patient who underwent phaco surgery using 0 and 30 degree phaco tips (z test= 1.42 and p value = 0.11.), however there was a statistically significantly difference in mean EPT, for 30 and 45 degrees (z test= 5.2 and p value =0.02.) and 0 and 45 degree phaco tips (z test= 9.2 and p value = 0.02)

Mean CDE comparison between 0 and 30 degree tips was not statistically significant, however there was a statistically significantly difference in mean CDE, for 30 and 45 degrees (z test= 4.28 and p value = 0.01) and 0 and 45 degree phaco tips (z test=8.71, p value>0.01) operated patients of cataract.

Most common intra operative complication was posterior capsular rent seen in 2.7 % of 0 degree phaco tip while 5.5% of 30 degrees and 5.5% of 45 degrees. Descemet's membrane (DM) detachment was seen in 2.7% in 0 and 30 degree while 5.2% of 45 degree tip. Iris capture, zonular dialysis and vitreous loss seen in 0, 2.7% and 2.7% of 0, 30 and 45 degree phaco tip **(Figure 2).**

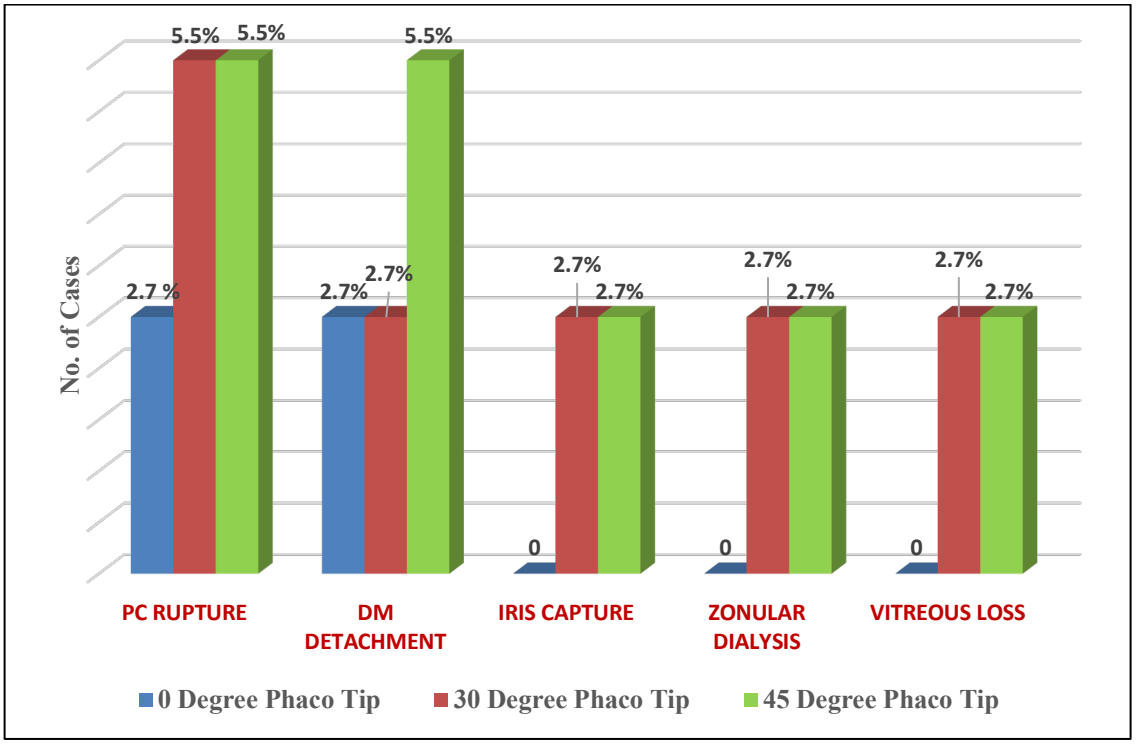

Fig 2: Intra operative complications for cataract surgery using 0, 30 and 45 degree Phaco Tips

There was no statistically significant difference while comparing mean cumulative dissipated energy (CDE) for 0 and 30 degree phaco tips (z test= 1.36 and p value = 0.17), However, there was statistically significant difference in CDE between 30 and 45 degree phaco tips. **(Fig 3)**

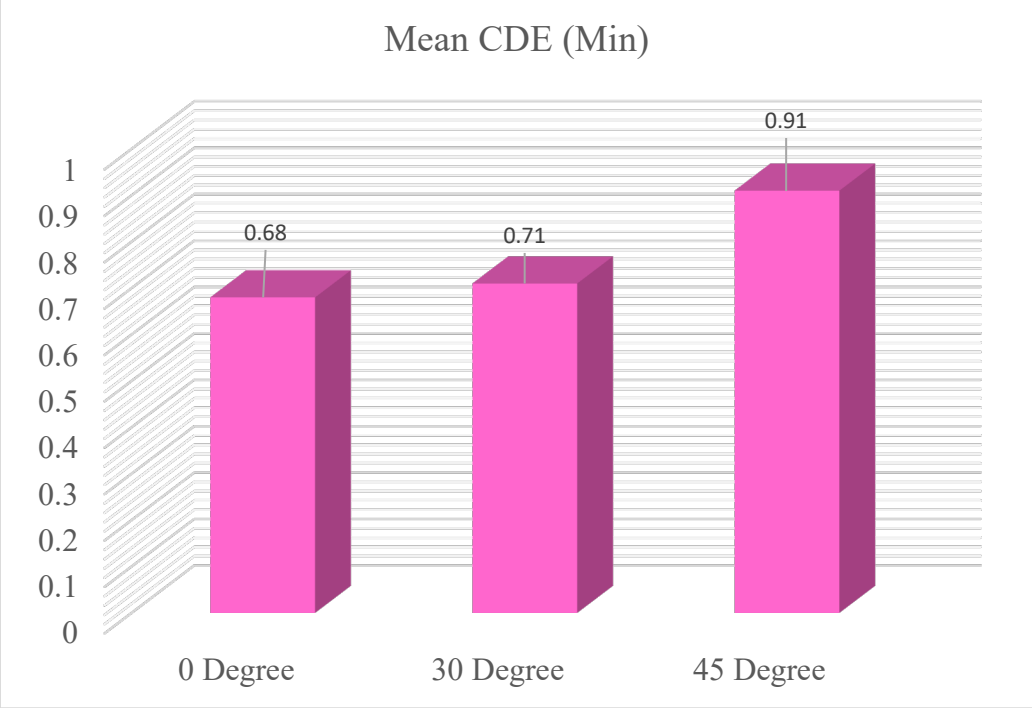

Fig 3: Mean CDE for 0, 30 and 45 degree phaco tip

Post-operative corneal clarity was seen to be 30.5 % for 30 degrees and 26.3 % for 45 degree phaco tip on Day 1 (z test=5.63, p value<0.05),38.8 % of 30 degrees and 36.1 % of 45 degrees on day 7(z=2.61, p value<0.05), 100 % on day 30, day 45 and 6 months (z test=0, p value>0.05) **(Table 2)**

Table 2: Day wise Post=Operative Corneal Clarity Day.

Post-Operative Day	Phaco Tip		
	0 Degree	**30 Degree**	**45 Degree**
DAY 1	37.50%	30.50%	26.30%
DAY 7	54.10%	38.80%	36.10%
DAY 30	100%	100%	100%
DAY 45	100%	100%	100%
6 MONTH	100%	100%	100%

Post operatively on Day 7, visual outcome depending on logMAR scale > 1 was41.6% in group A and 50% in group B (z= 1.98, p< 0.05). Similarly, on Day 7, clear cornea was seen in 61.1% group A and 33.3% in group B (z=2.0, p< 0.05). Post operatively on Day 30, visual outcome depending on logMAR scale > 1 was 27.7% in group A and 44.4% in group B (z= 0, p> 0.05). Similarly, on Day 30, clear cornea was seen in 100% group X and 100% in group Y (z= 0, p> 0.05). Post operatively on Day 45, visual outcome depending on logMAR scale > 1 was 0% in group A and 0% in group B (z= 0, p> 0.05). Similarly, on Day 45, clear cornea was seen in100% of group A and 100% in group B (z= 0, p> 0.05). Post operatively on 6 months, visual outcome depending on logMAR scale > 1 was in 0% group A and 0% in group B (z= 0, p> 0.05). Similarly, on 6 months, clear cornea was seen in 100% group A and 100% in group B (z= 0, p> 0.05).

Discussion

Phacoemulsification is the gold standard for cataract surgery and is preferred technique for cataract surgery in developed countries and to some extent to developing countries[5]. Phacoemulsification consists of sophisticated transducer that changes the mechanical to electrical energy

and accelerating needle that is phaco tip which allows the surgeon to divide nucleus and emulsify it. Phaco tips have variable tips varying from 0, 15,30,45,60 degrees.[6,7]

In the present study, we have compared EPT, CDE, visual outcome and corneal impact in phacoemulsification method of cataract surgery using 0, 30 and 45 degree phaco tip.

Clinically, hardness of nucleus grading is based on lens opacity classification system (LOCS) III classification after full pupil dilatation on slit lamp examination[8]. Higher grade of cataract requires the higher ultrasound energy for phacoemulsification which may be responsible for corneal damage. For this purpose, present study included various grades of nuclear sclerosis. Total 216 patients were divided into three groups A, B and C for various phaco tips i.e. 0, 30 and 45 degree phaco tip for Phaco surgery.

In the present study, we observed that most patients were in age group of 57 – 81 years. Mean age of male for group A was 69.22 years, group B was 66.71 years and for group C was 60.64 years. Mean age of female for group A was 68.88 years, group B was 66.66 years and for group C was 63.90 years. There was no statistical difference for sex distribution between A and B groups by C test ($z=0.62$, $p> 0.05$) and Y and Z ($z= 0.21$, $p> 0.05$) and X and Z group ($z= 1.2$, $p > 0.05$). This means that sex factor that reflect status of cornea and endothelial count was same in both groups. Males and females in group A were 36 each while in group B were 42 and 30 and in group C were 28 and 44 respectively. There was no statistically significant difference between the two groups by z test ($z= 0$, $p> 0.05$). Mean age of patients in group A, B and C were 69.05, 66.69 and 62.63 years respectively ($z< 1.96$, $p> 0.05$). There was no statistical difference between the two groups. This means there was no age factor that reflects status of cornea and endothelial cell count in both the groups.

In present study we found that EPT was 41.08±9.3 sec for group A and 41.38±13.76 sec for group B ($z= 1.42$, $p=0.11$). This means that no significant difference was seen in energy required for 0 degree compared to 30 degree phaco tip. Increased corneal damage was found to be due to increased phaco energy used to emulsify the lens. This means that 0 degree phaco tip was similar to 30 degree phaco tip. Intra operatively CDE was noted in each group. It was 0.68±0.1 min for group x and 0.71±0.2 min for group y ($z=1.36$, $p= 0.12$). While comparing 30 and 45 degree phaco tip we found that EPT was 43.38±13.76 sec and 54.80±19.83 sec for group B ($z= 5.2$, $p> 0.05$). Intra operatively CDE was noted in each group. It was 0.71±0.2 min for group B and 0.91± 0.3 min for group C ($z = 4.28$, $p= 0.01$). There was statistical difference between the two groups so 30 degrees was better than 45 degree phaco tip. There was no statistical difference between the two groups, so 0 degree was similar to 30 degree phaco tip.

In the present study most common intra operative complication was posterior capsular rupture were seen in 2.7% in group A and 5.5 % in group B ($z=1.0$, $p>0.05$). DM detachment was seen in 2.7% of both groups ($z=0$, p value> 0.05). Complications like iris capture, zonular dialysis, vitreous loss were found in 0% of patients in group A while in 2.7% in group B. No statistical difference was seen between the two groups in each of the complications ($z=1$, p value>0.05).

In the present study most common intra operative complication was posterior capsular rupture which was seen in 5.5% in group A and 5.5% in group B ($z= 0$, $p> 0.05$) while most common post-operative complication was striate keratopathy seen in 56.9% of group A and 68% of group B pts ($z =2.1$, $p < 0.05$). This was mainly due to reduced distance between phaco tip and the posterior surface of the cornea as of fear of to touch the posterior capsule leading to PC rupture. Post operatively on Day 1, visual outcome depending logMAR scale > 1 was 58.3%in group A and 56.5% in group B ($z=2.2$, $p= 0.01$). Similarly, on Day 1, clear cornea was seen in 55.5% group A and 25% in group B ($z= 2.4$, $p= 0.02$).

Using 30 and 45 degree phaco tip, **Helvacioglu F et al[8]**, found that 45 degree phaco tip provided more effective lens removal with a lower CDE and less CCT change than a 30 degree phaco tip.

Using 30 and 45 degree phaco tip, **Kim EK et al[9]**, found that 45 degree phaco tip provided more effective lens removal with a lower CDE and less CCT change than a 30 degree phaco tip.

Conclusion

We found that 0 degree tip was having similar visual outcome as 30 degree while both 0 and 30 degree had better visual outcome than 45 degree however, no difference was found in final best corrected visual acuity between 0, 30 and 45 degree phaco tip. It was also observed that 0 degree phaco tip was associated with decreased corneal damage as compared to 30 degree phaco tip and 30 degree with decreased damage than 45 degree phaco tip however, it did not affect final visual outcome.

0, 30 and 45 degree phaco tip was associated with same incidence of post-operative complication and it did not affect visual outcome. Also, Effective phaco time and Cumulative dissipated energy was similar in 0 degree tip compared to 30 degree tip and less in 30 than 45 degree phaco tip.

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