Original Research Article

A comparative study on the phaco time and corneal endothelial count in phacoemulsification using the stop & chop and divide & conquer techniques in Indian eyes

Muthusundari Arunachalam[1], Shankar Chokkalingam[1],
Premnath Gnaneswaran[1]*, Adnan Matheen[1], Shinisha Paul Bravian[1]

[1]Dept. of Ophthalmology, Chettinad Academy of Research and Education, Chennai, Tamil Nadu, India

ABSTRACT

Background: Cataract, a leading cause of curable blindness requires surgical management. Endothelium which is crucial for corneal transparency gets injured during intraocular surgeries like phacoemulsification. Various studies have compared the impact of different techniques of phacoemulsification on endothelium. But few studies conclude that Phaco time & endothelial loss is lesser in Stop & Chop than Divide & Conquer technique.

Materials and Methods: An Interventional study involving 30 eyes in Group A (Stop & Chop) and 30 in Group B (Divide & Conquer) with Nuclear sclerosis grade II and III, excluding any pre-existing corneal diseases and Glaucoma was conducted in a tertiary care teaching hospital. All pre-operative parameters were similar in both groups. Post-operative values of best corrected visual acuity (BCVA), intra ocular pressure (IOP), endothelial cell count, central corneal thickness (CCT), Absolute Phaco time were recorded. Data entered in Excel sheets and analysed with SPSS. Paired, Unpaired t tests were used. P value <0.05 was statistically significant.

Results: Mean Absolute Phaco time for Group A was shorter (25.10±10.54 s) than that for Group B (44.20± 6.94 s) with statistical significance (p<0.05). Mean cell loss & changes in endothelium were higher in Group B than Group A (p<0.05).

Conclusion: Absolute Phaco time was shorter in Stop & Chop than Divide & conquer as well as the corneal endothelial damage and changes were lesser in Group A. Hence Stop & Chop technique of phacoemulsification is recommended for less corneal morbidity.

1. Introduction

Opacification of the crystalline lens in eye is termed as cataract which may be congenital or acquired.[1] The commonest type is senile cataract.[1] It is a leading cause with regard to curable blindness worldwide that affects the quality of life of the individual, if not treated. The management of cataract is surgical, which over the years has undergone many significant changes like initially, the Intracapsular Cataract Extraction (ICCE) and then the Extra Capsular Cataract Extraction (ECCE) and its newer techniques.[2] In 1967, Charles Kelman introduced the Phacoemulsification technique which aimed at safer as well as effective method of removal of the cataractous lens.[3] It is modern method of cataract surgery wherein an ultrasonic hand-piece is used to emulsify the lens called as Phacoemulsification.[3]

Corneal endothelium and its function remain vital in order to maintain the transparency and state of

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* Corresponding author.
E-mail address: drprem1822@gmail.com (P. Gnaneswaran).

persistent dehydration of corneal stroma[4]. During phacoemulsification, the damage to the endothelium is attributed to the following – manipulation of the nucleus, ultrasonic energy generating heat at the phaco tip and any mechanical injury.[3] Alterations in the endothelium are considered as the important parameters of trauma following the surgical procedure and become essential for estimation of safety of various surgical techniques as the cells in the corneal endothelium do not regenerate.[4] Shepherd & Gimbel described the Divide & conquer technique, which provided safer type of surgery with lesser cell loss of the endothelium.[5,6] In 1993, the Stop & Chop method in order to crack the nucleus was highlighted by Nagahara with the purpose to use mechanical force for breaking nucleus into few smaller pieces thereby reduce the usage of ultrasonic power, that will in turn help to limit the loss of endothelial cells.[7] Wong et al reported the technique of Stop & Chop had involved a shorter time called phaco time as well as a lower absolute phaco-power in comparison to technique of Divide & conquer which led to reduced loss of endothelial cells.[8] Poyales-Galan and Pirazzoli reported less endothelial cell loss after Stop & Chop technique of phacoemulsification with follow-up up to 3 months postoperatively.[9]

Studies conducted in India as reported by Ramamurthy LB et al[10] has focused on effective Phaco time and Ultrasound time in different grades of cataract using Phacoemulsification. Kaur G et al reported though there was significant drop in endothelial density on comparing the pre-operative parameters to postoperative values in both Stop & Chop and Divide & conquer groups respectively but the difference in between the groups had no statistical significance.[11] There are some studies to favour the hypothesis that Stop & chop has lesser impact on the corneal endothelium in comparison with Divide & Conquer and some studies provide ambiguous results.

Hence this study was designed for comparison and analysis of Phaco time and loss of corneal endothelium in Stop & Chop as well as in the technique of Divide & Conquer of phacoemulsification performed in our setting in tertiary care centre.

2. Materials and Methods

An Interventional study involving 30 eyes in Group A (Stop &Chop) and 30 in Group B(Divide & Conquer) with Nuclear sclerosis grade II and III, excluding any pre-existing corneal diseases, small pupil, shallow AC, other complicated cataract, Glaucoma, was conducted during January-December 2021 in a tertiary care research institute. Elnaby EA et al[12] reported that the average loss of the endothelial cells during three months following the surgery in Stop & Chop arm of the study was 344.56 i.e. (13.86%) which was observed to be statistically significant with p <0.05. In Divide and Conquer, the average loss of

endothelial cells during the three months postoperative, was observed to be 449.48 i.e. (17.72%) which was also statistically significant with $p < 0.05$.

The difference in loss of endothelial cells during postoperative follow-up in between the two selected groups was observed to have statistical significance with P = 0.001, percentage difference – 3.86 percentage points, 22% reduced endothelial cell loss in Stop-Chop group). At 95% confidence level and a z value which is 1.96 with margin of error or the confidence interval (CI)was estimated at ± 15, Assuming that 95% CI, power as 80% for the study, the minimum calculated sample size that is required for this study was derived to be 30 per group. In this study we recruited 60 eyes fitting with inclusion criteria and they were allocated randomly into Group A and B (30 eyes in each intervention arm A and B).All pre-operative parameters were similar in both groups which were documented as case format. Pre-operative preparation, both procedures were conducted by the same Expert surgeon. The phaco time (secs) was recorded during the surgery and the mean (Average) Absolute Phaco time (secs) was calculated by multiplying phaco time with mean (average) phaco power in both the techniques of phacoemulsification. Absolute Phaco time (APT) = average phaco power x phaco time. Post-operative checkup for all participants was conducted for the following parameters: BCVA, slit lamp examination for state of corneal clarity, IOL position, Ocular tension, Tomey Specular Microscopy for Corneal Endothelial count, CCT – 1 week, 4 weeks and 6weeks postoperatively and documented. Data entered in Excel and analysed with SPSS. Paired, Unpaired t tests were used. A p value<0.05 was statistically significant.

3. Results

The mean age of the participants among the Group A was 58.70 ± 7.55 years and the Group B was61.17 ± 6.41 years. The difference in between the groups was not statistically significant (p=0.244). In Group A, 47% females and 53% males participated and in 43% were females and 57% were males in Group B. In both the groups, majority were of grade 3 Nuclear Sclerosis (LOCS - 3) which is described in Table 4. As far as duration of cataract was concerned, about 20 out of 30 in Group A had less than 1 year similar to Group B in which 21 out of 30 had less than 1 year. Pre-operative assessment of all patients in each group is as follows: Best Corrected Visual Acuity (BCVA) in Group A and Group B are given in Table 1.

Cornea was clear in all subjects. AC depth and size of the pupil were normal in all cases with normal IOP with Mean ± S.D =. 15.43±1.83 mm of Hg in Group A and that in Group B= 16.00±2.76 mm of Hg. Mean pre-operative Corneal Endothelial count in Group A was 2493.40 ± 191.85cells/mm^2 (Range: 2341-2800) and in Group B was 2460.90±161.31 cells/mm^2 (Range 2338-2889). The mean

Table 1: Details of BCVA –pre-operative period in both groups

BCVA pre-op	Group A n (%)	Group B n (%)	Total n (%)
6/18	0 (0%)	3 (10%)	3 (5%)
6/24	2 (6.7%)	3 (10%)	5 (8.4%)
6/36	17 (56.7%)	14 (46.6%)	31 (51.6%)
6/60	11 (36.6%)	10 (33.4%)	21 (35%)
Total	30 (100%)	30 (100%)	60 (100%)

CCT was 532.13±29.49 μ in Group A and that in Group B was 541.80± 50.82 μ. The difference between the two groups did not reveal statistical significance (p= 0.343) in all these parameters. Mean Phaco power was used in the similar manner in all the cases in both groups.

The Mean Absolute Phaco time in seconds for Group A technique was 25.10±10.54 while that for Group B was 44.20± 6.94. This difference in between two groups was observed to be statistically significant with p<0.01 (Table 2). The duration of Phacoemulsification was lesser in Stop & Chop procedure in comparison with Divide & Conquer with statistical significance.

Table 2: Mean absolute phaco time (Sec) between the two groups

Phaco time (seconds) in both Groups	Group A (Mean ± S.D.)	Group B (Mean ± S.D.)	p value
Phacoemulsification time	25.10 ± 10.54	44.20 ± 6.94	0.001

The parameters were assessed post-operatively by same investigator who was blind for the type of Phacoemulsification done for each Group during the first week, 4th week and 6 weeks from the procedure (Table 3). During the post-operative period and follow-up, all patients had normal IOP. Corneal edema and Descemet membrane (DM) folds were observed in few patients in both groups during the 1st week of follow-up which had completely resolved in the follow up during 4th and 6th week. Anterior chamber was found to be well formed in all patients post-operatively.

The difference observed in the endothelial cell count in the form of the loss of cell when compared to Pre-operative period with 1st week, 4th as well as 6^{th}week of follow-up in both the groups is as follows: There is progressive loss of corneal endothelial cells when compared to Pre-operative parameters to 1st week, 4th week as well as 6th week follow-up respectively in both groups (Table 4). But in both the intra- groups, the loss comparing the 4th as well as 6th week parameters, it was observed that the 6th week did not have further progressive loss than values recorded in 4th week.

The following (Table 5) describes the endothelial count and cell loss in Group A and that in the Group B when pre-operative parameters were compared with those during

1st, 4th and 6th week of follow-up. This difference had statistical significance in intra-group as well as intergroup (p<0.05) in 1st, 4th and 6th week post-operative period. In between the groups, 5.6% was the observed difference (%) of loss of endothelial cells on 6th week follow-up. It was observed that in between the 4th and 6th week of post-op period, the endothelial count had no significant reduction and the difference between the changes in 4th week in comparison with 6th week had no statistical significance.

The difference of mean endothelial cell loss at the 6th week follow-up had statistical significance that the cell loss was significantly lesser in Stop & Chop procedure (Group A) than that in Divide & Conquer technique(Group B)p<0.05.

The parameters like age of the subjects, gender, socio-economic status, grade and duration of cataract, did not have statistical significance for the corneal endothelial Cell loss in between the two Groups.

4. Discussion

Cataract, which is the opacification of the lens, is the leading cause of preventable blindness globally.[1,2] Cataract surgery is one of the commonest procedures in ophthalmology for which phacoemulsification is one of the procedures of choice for extraction of cataract followed by implantation of posterior chamber Intraocular lens (PCIOL).[2] Phacoemulsification which is performed in confined space is related with corneal endothelial cell loss wherein the degree or % of loss might be variable considerably. Corneal endothelium plays a vital role in the maintenance of the transparency and continuous dehydration of corneal stroma. Corneal endothelial cells are non-replicative and do not regenerate.[4] Hence to achieve better quality of postoperative vision, it is inevitable to preserve the corneal endothelial cells during the phacoemulsification. There are few studies available on the Phaco time consumed during the technique and loss of the endothelial cells in various techniques of phacoemulsification like Stop & Chop as well as Divide & Conquer with ambiguous results.[7–9] Hence this study compared the techniques of Stop & Chop and Divide & Conquer during phacoemulsification with regard to Phaco time as well as the loss of corneal endothelial cells in this tertiary care centre.

In this study, the mean age of the participants in Group A observed as 58.70 ± 7.55 years and that in Group B was 61.17 ± 6.41 years which was almost similar to the distribution of reported by Kaur G et al[11] and Madhumita Prasad et al.[13] The gender distribution in this study was similar to Kaur G et al[11] and that reported by Madhumita Prasad et al[13] which concluded that no sexual difference was observed when prevalence of the senile cataract was considered.

Table 3: Details of parameters during the follow-up

S. No.	Parameters		1st week Post-op		4th week post-op		6th week Post-op	
			Group A n=30	Group B n=30	Group A n=30	Group B n=30	Group A n=30	Group B n=30
1.	BCVA	6/6	0	3	8	7	9	7
		6/9	14	6	17	17	17	17
		6/12	11	12	4	6	4	6
		6/18	5	9	0	0	0	0
2.	Central Corneal Thickness (Mean) μ		550.33±34.52	572.0±85.61	536.77±29.91	549.2±92.15	535.67±31.88	546.70±89.62
3.	Endothelial cell count (Mean) cells/mm^2		2356.30±202.92	2258.50±205.43	2175.83±252.60	2031.20±212.15	2160.37±238.2	2012.80±225.29

Table 4: Endothelial cell loss between pre-operative period and follow-up

S. No.	Mean Endothelial cell loss (Difference from Pre-operative)	Group A (Mean±SD) cells/mm^2	Group B (Mean±SD)cells/mm^2
1.	Mean endothelial cell loss on 1st week (% loss)	135.70 ± 50.98 (5.4%)	201.50 ± 47.68 (8.21%)
2.	Mean endothelial cell loss on 4th week (% loss)	316.57± 60.75 (12.69%)	428.80 ±50.84 (17.42%)
3.	Mean endothelial cell loss on 6th week (% loss)	332.03± 46.35 (13.33%)	447.6 ± 63.98 (18.19%)

Table 5: Association between preoperative and postoperative endothelial cell count & loss in between the groups in 1st, 4th and 6th weeks follow-up

Endothelial cell count	Group A (Mean ± S.D.)cells/mm^2	Group B (Mean ± S.D.)cells/mm^2	p value *
Preoperative	2492 ± 191.85	2460 ± 161.31	0.485*
1 week postop	2356.30 ± 202.92	2258.50 ± 205.43	
Endothelial cell loss (From pre-op to 1 week postop)	135.70	201.50	0.031*
p value#	0.010#	0.000#	
4 weeks postop	2175.83 ± 252.60	2031.20 ± 212.15	
Endothelial cell loss (from pre-op to 4th week)	316	428.8	0.019*
p value#	0.003#	0.000#	
6 weeks postop	2160.37 ± 238.20	2012.40 ± 225.29	
Endothelial cell loss (from pre-op to 6 weeks postop)	332.03	447.60	0.016*
p value#	0.000#	0.000#	

p value <0.05 –significant # "paired t test" *"unpaired t test

Table 6: Association between type of surgery and endothelial cell loss at 6 weeks

Type of surgery	Endothelial cell loss 6 weeks post op (Mean ± S.D.) cells/mm^2	p value
Stop & Chop Technique	332.03 ± 63.38	0.000*
Divide & conquer Technique	428.50 ± 86.49	

Value < 0 05, unpaired t test

In this study, the Pre-operative endothelial cell count was 2493.40 ± 191.85 cells/mm^2 among Group A, while in Group B was 2460.90 ± 161.3 cells/mm^2. Elnaby EA et al had reported in their study that the Group (Stop & Chop) had mean density of pre-operative endothelial cells as 2488 cells per mm^2 and 2536.5 cells/mm^2 in Group (Divide & Conquer).[12] Rao SK et al in their study reported that in the Indian scenario among our population, the mean endothelial cell count (ECC) in age group from 20 to 87 years observed to be 2525 ± 337 (cell/mm^2).[14]

4.1. Absolute phaco time in between the groups

In this study, the mean(Average) Absolute Phaco time (APT) in Group A (Stop and Chop) technique was 25.10 ± 10.54 seconds while that for Group B was 44.20 ± 6.94 seconds with statistical significance ($p<0.05$). In this study, the Phaco time was shorter in Stop & Chop technique than Divide & Conquer technique with statistical significance as reported by Wong et al[8] with 17.4 seconds in Phaco-chop in comparison with 50.4 seconds in technique of Divide &Conquer and Pirazzoli et al who reported the mean time as 25.53 seconds in Stop & Chop technique and 87.26 seconds in Divide & Conquer.[9] El Sobky et al also reported the statistical significant difference in the equivalent Phaco time involved in Stop & Chop technique which was lesser than that in Divide & Conquer group.[15] Madhumita Prasad et al also reported the Absolute Phaco Time (APT) to be shorter in Phaco-chop group (16.58 ± 5.11 seconds) when compared to Divide and Conquer group (27.12 ± 10.15 seconds) which was statistically significant.[13] Elnaby EA et al had reported in their study that the Phaco-time was shorter in Stop & Chop than that in Divide & Conquer.[12] In this study, the pre-operative endothelial parameters in between the two Groups were similar and the difference was statistically insignificant. We followed the patients on 1st week, 4th week and on 6th week post-operative period and the details of which are discussed as follows: The mean (average) corneal endothelial count on the 1st week postoperative period in Group A was 2356.30 ± 202.92 cells/mm^2 and that in Group B was 2258.5 ± 205.43 cells/mm^2 where the difference had statistical significance in between the Groups. The mean (average) endothelial cell loss at 1st week in Group A was 135.70 ± 50.98 cells/mm^2 and that in Group B was observed to be 201.50 ± 47.68 cells/mm^2 in comparison with respective pre-operative parameters in each Group. The difference in the cell loss observed between the two Groups had statistical significance. Madhumita Prasad et al had reported that mean endothelial cell count (ECC) during the first post-operative week follow-up 2324.2 ± 276.11 cells/mm^2 in Phaco-chop group and the group with Divide and Conquer to be 2062.78 ± 260.54 cells/mm^2 and the difference had statistical significance[12]. Also Madhumita Prasad et al had highlighted the difference

which was observed in the mean (average) endothelial cell loss was higher in Divide & conquer technique when compared to Stop & Chop during the first week follow-up.[13] Elnaby EA et al had reported the statistical significance in loss of endothelial cells only at three months after the procedure in their study.[12] Pirazzoli and colleagues have also reported the difference in loss of endothelial cells at 3 months postoperatively to have statistical significance which was lower in Stop & Chop than Divide & Conquer technique.[9] El sobky HM et al had reported the mean (average) endothelial cell loss during both the techniques when compared to pre-operative parameters but the difference in between two groups had no statistical significance at 3 months post-operative period.[15]

The Mean corneal endothelial (ECC) count on 4th week following the procedure in Group A was observed to be 2175.83 ± 252.60 cells/mm^2 and mean ECC in Group B was 2031.20 ± 212.15 cells/mm^2 where the difference had statistical significance in between the two groups. The mean (average) endothelial cell loss on 4th week among Group A was 316.57 ± 60.75 cells/mm^2 and that in Group B was observed to be 428.8 ± 50.84 cells/mm^2 in comparison with respective pre-operative parameters in each group. The difference in cell loss between the 2 groups had statistical significance at 4th week follow-up. The mean (average) endothelial cell count on 6th week among Group A was 2160 ± 238.2 cells/mm^2 and that in Group B was observed to be 2012.8 ± 225.29 cells/mm^2 where the difference had statistical significance in between the two groups. The mean (average) endothelial cell loss on 6th week among the Group A was 332.03 ± 46.35 cells/mm^2 and that in Group B was observed to be 447.6 ± 63.98 cells/mm^2 in comparison with respective pre-operative parameters in each group. The difference in cell loss in between the groups had statistical significance at 6th week follow-up.

Madhumita Prasad et al had highlighted the difference in the mean(average) loss of endothelial cells which had statistical significance was higher in Divide & Conquer technique than Stop & Chop on 6th week follow-up.[13] Elnaby EA et al had reported the statistical significance in loss of endothelial cells during their postoperative follow-up in their study.[12] Pirazzoli and colleagues have also reported the difference in loss of endothelial cells postoperatively be statistically significant which was lower among the Stop & Chop than that of Divide & Conquer technique.[9] El sobky HM et al had reported the mean loss of endothelial cells during both the techniques when compared to pre-operative parameters but the difference in between the two groups did not have statistical significance during follow-up at 3 months.[15] Madhumita Prasad et al highlighted that longer the Phaco time, higher is the endothelial cell loss.[13] So Stop & Chop consumes less time and lesser is the harm on the corneal endothelium. Larger sample size and longer follow-up period, could throw more light on the

advantage of Stop & Chop technique of phacoemulsification in terms of Phaco time consumed showing lesser harm on the corneal endothelium in comparison with Divide & conquer technique. However as there was no significant difference in CCT and changes in endothelial cell count between the 4th and 6th week postoperative follow-up, we may not anticipate further significant changes post 6 weeks period.

5. Conclusion

This study highlights that the Stop & Chop technique involves lesser Phaco time and lesser corneal endothelial damage in comparison with Divide & Conquer technique of phacoemulsification.

6. Source of Funding

7. Conflict of Interest

None.

Acknowledgment

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Author biography

Muthusundari Arunachalam, Resident https://orcid.org/0000-0001-8425-2077

Shankar Chokkalingam, Professor https://orcid.org/0000-0002-9956-6703

Premnath Gnaneswaran, Professor https://orcid.org/0000-0002-8867-2914

Adnan Matheen, Associate Professor https://orcid.org/0000-0002-7157-9270

Shinisha Paul Bravian, Associate Professor https://orcid.org/0000-0002-3686-5060