ORIGINAL ARTICLE

Comparison between different techniques of phaco emulsification divide and conquer and horizontal chop

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Abstract

Objective: Comparison between different techniques of phaco emulsification

Background: KELMEN in 1967 introduce phaco-emulsification for cataract removal aiming to find a safe and effective way of removing lens. At present phaco-emulsification is the procedure of choice for cataract extraction for most ophthalmologists.

Material and Methods: This prospective study include 150 eyes of 150 patients attending the out patient department of Ziauddin Hospital, north campus and Civil Hospital, Karachi. Patient ages between 40 to 60-years with senile cataract, nuclear grade from 2 to 4 under went detail history taking full ophthalmic examination, A&B scan, Corneal pachymetry and endothelial cell count (ECL) and nuclear grading. All patient were operated by the same surgeon using Laurette Alcon Phaco Machine. Study was conducted between 1st June, 2018 to 30th June, 2019.

Results: Statically significant endothelial cell loss (ECL) following all study technique. 3-months post-operatively (12.6 & 10.5 in group-I & group-II respectively). The nuclear grade and absolute phaco time had positive correlation with higher ECL whereas age, sex, axial length, did not effect ECL. Significant increase in central corneal thickness (CCT) was observed at immediate post-operative week. Among two study group (14% & 10.5% respectively). There was no statistically significant different between the two groups. Post-operative CCT pachymetry values were return to pre-operative value at 3-months post-operatively.

Conclusion: Significant & equal endothelial cell count occur after two study technique. Absolute pahco time and nuclear grade has a positive co relation with higher ECL. Age, sex, and axial length donot effect ECL. CCT increase significantly and equal post-operatively following 2-techniques.

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Keywords: Absolute phaco time, divide and conquer, horizontal chopping, phaco emulsification, specular microscopy.

Introduction:

Kelman in 1967 introduced ultrasonic phaco-emulsification for cataract removal aiming to find a safer and more effective way of removing the lens. Phaco-emulsification nowadays is the procedure of choice for cataract extraction for most ophthalmologists.

Divide-and-conquer technique, described by Gimbel, was the first nucleofractis cracking techniques developed[1,2] provided safer surgery with less endothelial cell loss (ECL).[3]

Koch and Katzen[4] modified the Nagahara technique because they encountered difficulty in mobilizing the nuclear fragments. They created a central groove or central crater to provide a space that facilitates the chopping procedure and removal of nuclear pieces. Controversy of endothelial cell damage after different phaco-emulsification techniques has been reported as the cause of carrying out this study.

Material and Methods:

All patients were operated by experienced

Table 1: *Absolute phaco time among the studied groups*

APT	Groups	
	Group-I	Group-II
Average (S)	48.47	22.57
SD	9.01	5.58
Minimum (S)	23	14
Maximum (S)	60	40

APT, absolute phaco time

Table 2: *Comparison between pre-operative and post-operative endothelial cell counts and post-operative ECL in the studied groups*

	Group I (means ± SD)(cell/mm2)		Group II(means ± SD)(cell/mm2)	
	Count	Pre-operative and post-operative endothelial cell count	Count	ECL
Pre-operative	2626.47±255.19		2604.3±206.23	172.87±154.75
Post-operative				
1 week	2114.73±472.66	511.73±408.68	2440.07±256.83	
P value	0.000		0.002	
3 months	2038.20±463.83	558.33±403.36	2381.67±270.68	233.53±169.94
P value	0.000		0.000	

ECL endothelial cell loss Paired t-tests

Table 3: *Comparison between pre-operative and post-operative endothelial cell counts and post-operative ECL in the studied groups*

Time	CCT (means ± SD)(mm)		P
	Group I	Group II	
Pre-operative	505.33±42.81	508.87±39.70	0.816
Post-operative			
1 week	559.0±33.92	542.47±47.49	0.277
P value	<0.001	0.046	
3 months	505.80±40.01	522.53±35.18	0.234
P value	0.924	0.324	

CCT. central comeal thickness; Paired -t-test

surgeons the all surgeons used Laurette Alcon Phaco Machine (USA). Patients were randomly assigned to one of the 2-groups. The study was conducted for 1-year period from 1st June 2018 to 30th June 2019.

Group-l (included 75 eyes): ln this group phaco-emulsification was performed using the divide-and-conquer technique

Group-ll (included 75 eyes): In this group phaco-emulsification was performed using the horizontal chopping technique

Nuclear fracture technique: Nuclear fracturing technique was different for each group as follows.

In group-1 (Divide and Conquer technique): ln the divide-and-conquer group, two memory programs were used Phaco-1 was used for sculpting [maximum 70% ultrasound (US) power; vacuum, 20 mmHg; flow rate, 20-25 ml/min; and bottle height, 70-80 cm]. Phaco-2 was used for quadrant removal (maximum 50% pulsed mode US power; maximum vacuum, 350 mmHg; flow rate, 25-30 ml/min; and bottle height, 90-110 cm)

In group-2 (horizontal chopping technique): The phaco-1 program was excluded and only the pulse-mode program, phaco-2, was used and after the superficial cortex and epi-nucleus were aspirated, the phaco tip was buried in the center.

The endo-nucleus at a high vacuum setting (350 mmHg), next, the Nagahara phaco chopper was brought through the side-port incision, and the equator of endo-nucleus was engaged by the chopper under the capsulo-rhexis. The chopper was moved toward the phaco probe to initiate nuclear cracking. Both instruments were moved in opposite directions, dividing the nucleus into halves. The nucleus was then rotated through 90°, the phaco tip was impaled in the interior hemi-section of the nucleus, and the chopper was used to break this half into two smaller fragments, which were then emulsified. The procedure was repeated on the superior nucleus. The following were noted during surgery.

1. The total phaco time (s)
2. The mean phaco power (%)
3. Total phaco energy (the absolute phaco time, APT) was calculated by multiplying the phaco time (Sec) by mean phaco power (%), operative complication such as posterior capsule rupture or iris trauma was also reported.

Results:

Absolute phaco time: Study of the US time consumed during the operation indicated by APT [US energy (%) x US duration (s)] for the 2-groups is shown in table-1. There was a

Table 4: *Stratification of Bacterial Pathogens with age (n=40)*

Visits	CCT (mean±SD) (µm)				
	Divide and Conquer		Horizontal Chop		P
	Increased CCT	%	Increased CCT	%	
1 week	14±5.7	2.7	10.5±11.4	2.1	0.863
3 months	1.4±1.8	0.3	0.6±2.3	0.1	0.635

CCT, central corneal thickness

Table 5: *Stratification of bacterial pathogens with age (n=40)*

Grades	Groups		Total (n(%))
	Group-I (Divide and conquer) (n(%))	Group-II (horizontal chop) (n(%))	
Grade-2	2 (13.5)	3(20)	5(16.5)
Grade-3	10(66.5)	9(60)	19(63.5)
Grade-4	3(20)	3 (20)	6(20)

P=0.881 (insignificant)

statistically significant difference between the 2-groups (P < 0 001).

Endothelial cell count and endothelial cell loss: All groups had a significant decrease in endothelial cell counts at 1-week and 3-months post-operatively [table 2] revealed the means of endothelial cell densities pre-operatively and during the follow-up period.

Means of ECL post-operatively are also included in table-2.

Central corneal thickness: The course of central corneal thickness (CCT) changes among the studied groups during post-operative follow-up period was illustrated. All groups showed a significant increase in central corneal thickness.

Table-3 compare post-operative means of central corneal thickness with pre-operative values in the studied groups. There was a significant difference between pre-operative central corneal thickness and post-operative central corneal thickness at 1-week post-operatively in all groups. There was no significant difference between pre-operative central corneal thickness and post-operative central corneal thickness at 3 months in all studied groups.

The amount and rates of increased central corneal thickness during the post-operative follow-up period, at 1-week and 3-months] among the studied groups are shown in table 4. There was no significant difference seen between the 2-groups.

Nuclear grades: According to LOCS Ill classification system, nuclear firmness in this study was classified into three grades; grade 2, grade 3, and grade 4. Most cases were of grade 3 (moderate nuclear firmness). Table 5 represents the detailed distribution of nuclear grade among the two groups.

Discussion:

This study was conducted from 1st June, 2018 to 30th June, 2019. ln the present study, the mean ECL after the divide-and-conquer technique at 3-months post-operatively was 12.4. This result is comparable to that of O'Brien et al (11.6%).[5] Storr-Paulsen et al.[6] reported an ECL less than that of the present study (5%), whereas Al-Sharkawy[7] reported a higher ECL (15.20%).

ECL among the horizontal-chop group in the present study was 10.5% lt was much higher than that of Storr-Paulsen et al.[6] 6.3%. In contrast to these results, Park et al.[8] reported much higher ECL 3-months post-operatively following horizontal-chop technique (16.3%). This discrepancy of results may be explained by the variation in surgeon's experiences and differences in the phaco machines and instruments used.

ln the present study, there was a significant post-operative ECL among all studied groups. Comparison between these groups showed no significant statistical difference regarding post-operative ECL. Storr-Paulsen et al[6] compared ECL following divide-and-conquer versus horizontal-chop techniques.

Their findings were similar to the present study, as there was no significant difference in post-operative ECL after 3-months. Contrary to this, Pirazzoli et al.[9] reported a significant lower ECL following horizontal-chop technique. (16.3%) Other investigators, wong et al[10] showed that US energy use was significantly less in the horizontal-chop technique than that of divide-and-

conquer technique, but endothelial cell damage was not evaluated in their studies.

ln the present study, the total US consumption (APT) in the divide-and-conquer group was 48.47, wong et al reported higher APT means in two studies:[10] a mean of 58.8 in a pilot study and 50.4 in a prospective study. The studies by Can et al[11]and Storr-Paulsen et al.[6] showed there was no positive correlation between total US Energy & ECL.

The mean APT following phaco chop technique in the present study was 22.57. This is comparable to that reported by Can et al. Higher means were documented by Vajpayee et al.[12] (28 s). Some studies reported much lower APT after phaco chop technique, less than 10 in the study by Suzuki et al,[13] and 3.98 in the study by Storr-Paulsen et al.[6] The discrepancy between the result of the present study and other studies can be attributed to variations of surgeons experiences and using different phacomachines.

A wong et al revealed that horizontal-chop technique involved a significant shorter phaco time and lower absolute phaco power than the divide-and-conquer technique, leading to less ECL. They postulated that less total energy leads to less endothelial cell damage. This hypothesis was confirmed by O'Brien et al,[5] whereas the present study and the study by Storr-Paulsen et al[6] showed that there was no positive correlation between the total US energy and ECL.

Measuring the difference in pachymetry at the first post-operative day is a useful way to assess the effects on the corneal endothelium exerted by the phaco-emulsification procedure. The increase in central corneal thickness seen on the first post-operative day is strongly correlated with the corneal ECL at 3-months post-operatively.[14] ln the present study, there was a significant increase in central corneal thickness at the immediate post-operative day. There was no significant difference between the two studied techniques.

Rates of increased central corneal thickness post-operatively in the present study are parallel to that reported by Lundberg et al.[14,21] and Park et al.[8,23] Higher rates were reported by others: Abo El-Khir et al[15] and Can et al.[11,22] The time interval of cornea recovery and returning to the pre-operative pachymetry values was different in different studies, and it may be attributed to the different types of pachymetry devices used in measuring the central corneal thickness in the present study, the pre-operative pachymetry values were resumed at 3-months post-operatively. Can et al[11] reported a shorter time interval (10-14 days).

Similar to the current study, Vajpayee et al,[12,21] Storr-Paulsen et al.[6] and Park et al.[8] did not find a significant difference between the studied phaco techniques regarding the increase of central corneal thickness.

Transient post-operative corneal edema is sometimes noted after phaco-emulsification surgery,[16,25] indicating affection of the corneal endothelial pump function.[17,20] Results of the study by Lundberg et al.[14] indicated that clinically significant post-operative corneal edema was strongly associated with a clinically significant corneal ECL. The incidence of post-operative corneal edema in the present study was 30% and 20% in the in the divide-and-conquer and horizontal-chop groups, respectively. A significant difference was found in advantage of the horizontal-chop technique.

Phaco-emulsification technique has the advantage of early visual rehabilitation after cataract surgery, and this is mainly attributed to the small incision size used. However, phaco-emulsification is an expensive technique; hence, it is not an affordable technique in the developing countries with very low income. Manual small incision cataract surgery with its suture-less and relatively smaller incision has similar advantages to phaco-emulsification and is affordable hence, it is a good alternative to phaco-emulsification.

ln this study using both techniques, it was found that both techniques can give excellent visual results. However it was found that there is an

increased incidence of posterior capsule opacification in the manual small incision cataract surgery group.[18,19]

Conclusion:
Significant and equal ECls occur following the two studied techniques. APT and nuclear grade have positive correction with higher ECL. Age, sex, and axial length do not affect ECL.

CCT increases significantly and equally post-operatively following the two techniques. Divide and conquer is the easiest technique, whereas phaco chop is the most difficult technique and it needs longer learning curve.

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Dr. Mir Amjad Ali, collected the data, references and did the initial writeup.

Dr. Shehla Darasheni, helped in collecting the references and discussion writeup

Dr. Faiz Ur Rub, helped in collecting the data and tabulation of data.

Dr. Iftikar Ahmed, collected the data and references.

Dr. Mashood Uz Zafar, collected the data, references and also helped in result writing.

Dr. Nusrat Shah Khan, critically review the article and made useful changes.

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