

Assessment of Different Techniques of Nucleotomy during Phacoemulsification: A Comparative Study

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Abstract

Aim: The aim of the present study was to compare different techniques of nucleotomy during phacoemulsification with respect to corneal endothelial cell loss, central corneal thickness (CCT).

Methods: A comparative analysis on corneal endothelial cell loss and central corneal thickness was done in 90 patients undergoing cataract extraction by phacoemulsification in Department of Ophthalmology. These 90 patients were randomly divided into three groups of 30 each who underwent a different method of nucleotomy during phacoemulsification and were operated by the same surgeon.

Results: The maximum number of patients was in Group A, 17 patients were in the age group of 61-70 years while most of the patients, 18 in Group B and 21 in Group C, were in the age group of 51 – 60 years. The mean age of patients in Groups A, B and C were 60.65 years, 61.25 years and 59.45 years respectively. There were more females and most of the patients belonged to NS grade I. The maximum number of patients in each group: 11 patients in Group A had visual acuity of 6/36 preoperatively, 14 patients in Group B and 16 patients in Group C had visual acuity of 6/60 preoperatively. No statistically significant difference was found in mean endothelial cell density in Group A, B and C preoperatively. No statistically significant difference was found in mean central corneal thickness in Group A, B and C preoperatively, and at 1st, 4th and 12th postoperative week. It was observed that CCT after 4 weeks of cataract surgery was not much different from preoperative value in all three groups. No patient of any group had BCVA of less than 6/36 on Snellen's distance visual acuity chart with spectacles correction.

Conclusion: All three techniques of nucleotomy in phacoemulsification i.e divide & conquer, stop and chop and direct phaco chop are equally efficacious. The degree of endothelial cell loss and central corneal thickness changes in all three methods are almost similar in the hands of an experienced surgeon.

Keywords: Endothelial cell loss, Nucleotomy, Phacoemulsification

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Introduction

Several variations of phacoemulsification techniques have been described. Of these, the divide-and-conquer, stop-and-chop, and phaco-chop are the most popular techniques. In divide-and-conquer, ultrasound (US) power is used to produce a central groove. The nucleus is then divided into two hemi-sections by cracking. The hemi-sections are rotated 90° so that the two halves lie at the 6 and 12 o'clock positions. Next, another longitudinal groove is produced and the nucleus is divided into four quadrants by cracking. The US power required throughout the procedure tends to increase. [1]

Compared to the divide-and-conquer, the use of a chopper decreases the US power required for

sculpting the nucleus. [2] The nucleus is mechanically divided into small fragments with a chopper in the stop-and-chop and Nagahara's phaco-chop techniques. Both techniques involve occlusion using high vacuum to stabilize the nucleus. [1–3] The main difference between the phaco-chop and stop-and-chop techniques is the creation of a central groove at the start of the procedure. The stop-and-chop technique begins by creating a central groove. Next, the chopper is inserted into the groove and a horizontal movement is performed to crack the nucleus in half. The cracking procedure is then stopped and the US tip is impaled into one hemi-nucleus. The chopper is used to create two or more

smaller fragments, which are then emulsified and aspirated. The initial central groove aids the surgeon to ensure the phaco tip reaches the correct depth to hold the nucleus.

The chopping technique is appropriate for moderate to hard nuclei. The hemi-section is embedded at mid-depth and chopped into two or more pieces while maintaining foot pedal position. Each piece is impaled, brought into the AC, and emulsified. In cases with solid nuclei, it is efficient to chop using occlusion because maintaining the occlusion is relatively easy. [1,2] However, it can be technically difficult to achieve and sustain occlusion to hold an un-solid (soft to moderate) nucleus since the US tip tends to aspirate and perforate soft nuclear matter. [4,5] Divide-and-conquer technique, described by Gimbel, was the first nucleoproteins cracking technique developed. [6,7] It provided safer surgery with less endothelial cell loss. [8] In 1993, the Phaco-chop technique for nucleus cracking was described by Nagahara. The main purpose of this technique was to mechanically break the nucleus into smaller fragments, to decrease the use of ultrasonic power and limit Endothelial Cell Loss (ECL). [9]

The aim of the present study was to compare different techniques of nucleotomy during phacoemulsification with respect to corneal endothelial cell loss, central corneal thickness (CCT).

Materials and Methods

A comparative analysis on corneal endothelial cell loss and central corneal thickness was done in 90 patients undergoing cataract extraction by phacoemulsification in Department of Ophthalmology, Patna Medical College and Hospital, Patna, Bihar, India, from September 2017 to August 2021. These 90 patients were randomly divided into three groups of 30 each who underwent a different method of nucleotomy during phacoemulsification and were operated by the same surgeon.

Group A: 30 patients who underwent nucleotomy by divide and conquer technique

Group B: 30 patients who underwent nucleotomy by stop and chop technique

Group C: 30 patients who underwent nucleotomy by phaco chop technique

Inclusion Criteria

1. Patients >50 years of age, with grade I-III immature senile cataract.

Exclusion Criteria

1. Hazy cornea
2. Pre-operative endothelial cell count <1000/mm²
3. Very shallow anterior chamber
4. NS grade IV/V
5. Non-dilating pupil
6. Subluxated or dislocated cataractous lens

A detailed history regarding name, age, sex and duration of diminution of vision, coloured halos, diplopia/polyopia was recorded. Past history of any ocular trauma, any local eye infection or previous ocular surgery was taken. Each patient underwent pre-operative evaluation including general physical examination, BCVA, detailed slit lamp examination, NS grading, fundus examination, IOP measurement by GAT and regurgitation test to check the patency of nasolacrimal duct. The hardness of the nucleus was clinically graded, depending upon its colour on slit lamp examination as follows:

Grade I (soft) – white or greenish yellow Grade II (soft – medium hard) - yellowish Grade III (medium hard)-amber

Grade IV (hard) – brownish Grade V (ultrahard) - blackish

Specular microscopy was done pre-operatively in each patient by TOPCON SP 3000P specular microscope and corneal endothelial cell count and central corneal thickness was recorded. After taking written informed consent, patient underwent phacoemulsification by pre-decided nucleotomy technique under peribulbar block.

All patients were followed up on post-op day 1 and later after 1 week, 4 weeks and 12 weeks post-operatively. On every visit, BCVA was tested and a complete slit- lamp examination was carried out. Specular microscopy was done using the non-contrast specular microscope TOPCON SP 3000P to assess the corneal endothelial cell count and central corneal thickness at 1st, 4th and 12th weeks of follow-up.

At the end of the study, the data was compiled and tabulated in Microsoft Excel spread sheet. Then statistical analysis of data was done with SPSS (Statistical Package for Social Sciences) ver. 21.0. The data was analysed using the student's paired t-test for intragroup and independent t-test for intergroup comparisons.

Results

Table 1: Baseline characteristics

Age Group	Group A	Group B	Group C
51-60 years	13	18	21
61-70 years	17	11	8
71-80 years	-	1	1
Sex			
Male	12	15	16
Female	18	15	14
Nuclear hardness			
NS Grade I	6	9	6
NS Grade II	15	12	12
NS Grade III	9	9	12

The maximum number of patients was in Group A, 17 patients were in the age group of 61-70 years while most of the patients, 18 in Group B and 21 in Group C, were in the age group of 51 – 60 years. The

mean age of patients in Groups A, B and C were 60.65 years, 61.25 years and 59.45 years respectively. There were more females and most of the patients belonged to NS grade I.

Table 2: Preoperative visual status

Visual Acuity	Group A	Group B	Group C
>6/18	0	0	0
6/24	6	4	0
6/36	11	6	8
6/60	9	14	16
5/60	1	1	1
4/60	1	2	1
3/60	1	2	1
2/60	0	1	0
1/60	1	0	3
<1/60	0	0	0

The maximum number of patients in each group: 11 patients in Group A had visual acuity of 6/36 preoperatively, 14 patients in Group B and 16 patients in Group C had visual acuity of 6/60 preoperatively.

Table 3: Comparison of mean endothelial cell density

	Group A (mean + SD)	Group B (mean ± SD)	Group C (mean + SD)	P value
Preoperative	2320± 66.84	2308.2±76.24	2312.8± 58.18	>0.05
1 st postop week	2155.2±66.81	2156.4±74.19	2153.65±55.56	>0.05
4 th postop week	2104.96±64.56	2086.4±72.06	2096.24±52.88	>0.05
postop week 12 th postop week	2066.24±62.58	2052.8±70.02	2058.2±532.36	>0.05

No statistical significant difference was found in mean endothelial cell density in Group A, B and C preoperatively.

Table 4: Comparison of central corneal thickness

	Group A (mean ± SD)	Group B (mean ± SD)	Group C (mean + SD)	P value
Preoperative	0.502± 0.024	0.494 ± 0.016	0.498 ± 0.015	>0.05
1 st postop week	0.516 ±0.023	0.505 ± 0.015	0.508 ± 0.015	>0.05
4 th postop week	0.505±0.022	0.496±0.016	0.501±0.014	>0.05
12 th postop week	0.502±0.028	0.494±0.016	0.499±0.014	>0.05

No statistical significant difference was found in mean central corneal thickness in Group A, B and C preoperatively, and at 1st, 4th and 12th postoperative week. It was observed that CCT after 4 weeks of cataract surgery was not much different from preoperative value in all three groups.

Table 5: BCVA at 12th postoperative week

BCVA	Group A	Group B	Group C
6/6	9	5	5
6/9	8	13	14
6/12	7	10	5
6/18	4	0	1
6/24	1	1	5
6/36	1	1	0
6/60 or less	0	0	0

No patient of any group had BCVA of less than 6/36 on Snellen's distance visual acuity chart with spectacles correction.

Discussion

Corneal endothelial cell loss is an inevitable complication following cataract surgery and occurs after any cataract technique. [10] The corneal endothelium is vital for the maintenance of corneal transparency. This is accomplished by its effectiveness in keeping the corneal stroma in a state of continuous dehydration through two main actions - active fluid pump and barrier function. Any compromise in these activities has a direct effect on corneal clarity. Cataract extraction with phacoemulsification is one of the most common surgical procedures performed today. [11] The normal corneal thickness and transparency are maintained by corneal endothelium. Endothelial alterations are considered important parameters of surgical trauma and also essential for estimating the safety of surgical techniques. Endothelial cell density decreases at a greater rate after cataract surgery than it does in healthy; previously unoperated corneas. [12]

The maximum number of patients was in Group A, 17 patients were in the age group of 61-70 years while most of the patients, 18 in Group B and 21 in Group C, were in the age group of 51 – 60 years. The mean age of patients in Groups A, B and C were 60.65 years, 61.25 years and 59.45 years respectively C which was almost similar to results of Gogate et al [13], where average age of patients in the phacoemulsification group was 63.7 years. There were more females' which was similar to findings of Martinez et al [14], who concluded that there is no sexual difference in the prevalence of senile cataract. and most of the patients belonged to NS grade I. The maximum number of patients in each group: 11 patients in Group A had visual acuity of 6/36 preoperatively, 14 patients in Group B and 16 patients in Group C had visual acuity of 6/60 preoperatively. The similar outcome was seen in a study conducted by Storr-Paulsen A et al where 60

patients were divided into 2 groups: one underwent cataract surgery by divide and conquer and the other by phaco chop. [15] However, visual acuity of individual group was not consistent with Ruit S et al., in which 98% of patients in phacoemulsification group had a BCVA of 6/18 at 6 months of postoperative follow up. [16]

No statistical significant difference was found in mean endothelial cell density in Group A, B and C preoperatively. No statistical significant difference was found in mean central corneal thickness in Group A, B and C preoperatively, and at 1st, 4th and 12th postoperative week. It was observed that CCT after 4 weeks of cataract surgery was not much different from preoperative value in all three groups. No patient of any group had BCVA of less than 6/36 on Snellen's distance visual acuity chart with spectacles correction. Further, comparison of CCT at 4th and 12th week was made and it was seen that the value returned to almost same as preoperative ones at 4th week and equal to preoperative values at 12th week of follow up. The similarity in three groups is supported by a study conducted by Storr-Paulsen A et al [15], who compared phaco-chop and divide & conquer and found no statistically significant difference in CCT change at 3 months postoperatively. The initial increase in CCT at 1st week in three groups is attributed to the mechanical injury caused by anterior chamber instrumentation, ultrasonic vibration, heat generated by ultrasonic tip and prolonged intraocular irrigation. Srinivisan et al [17] concluded in their study that there was an initial loss of endothelial cells, increase in CCT and changes in cell morphology and these values returned to normal within 3 months of surgery.

Conclusion

All three techniques of nucleotomy in phacoemulsification i.e divide & conquer, stop and chop and direct phaco chop are equally efficacious. The degree of endothelial cell loss and central corneal thickness changes in all three methods are almost similar in the hands of an experienced surgeon.

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