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COMPARATIVE STUDY OF 'DIVIDE AND CONQUER' VERSES 'STOP AND CHOP' TECHNIQUE OF NUCLEOFRACTISE IN PHACOEMULSIFICATION

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ABSTRACT

Introduction: The term 'Cataract' derived from Greek which means 'Water fall'. The senile cataract is the leading cause of Treatable Blindness in world. Our study is limited to the two techniques called "Divide and conquer" and 'stop and chop'. **Aims and Objectives:** Our study will be designed to compare the "divide & conquer" and "stop & chop" techniques of nucleofractise during phacoemulsification with respect to - Duration of phaco and Energy required. Incidence of corneal edema. Visual outcome in techniques under study. Intraoperative and Postoperative complications during both techniques. **Materials and Methods**: This study will be designed to compare the 'Divide and Conquer' technique with that of the "stop and chop" technique with respect to phaco time and energy required, incidence of corneal odema, visual outcome and intraoperative and post operative complications. The work was done on the cases of uncomplicated senile cortical cataract admitted to the Upgraded Department of Ophthalmology, Darbhanga Medical College & Hospital, Laheriasarai, for cataract extraction by phacoemulsification technique. **Divide and Conquer Technique** Trenching Cracking the Nucleus **Stop and Chop technique** Central Sculpting Broken into two halves Chopping and Emulsification **RESULTS:** The average time and effective phaco time required in Divide & Conquer technique was more than stop and chop technique. There was no significant difference statistically among the two technique of nucleotomy ($p>0.05$). By the end of the study, all the patients in all two groups had the visual acuity of 6/9 or better **CONCLUSIONS:** Nucleotomy techniques stop &chop and divide& conquer are safe and effective regarding effective phaco time, Post-operative corneal status.One should select any one type of nucleotomy technique and perfect on that particular technique to achieve excellency.

KEYWORDS: Nucleofractise, phaco time, corneal oedema.

MATERIALS AND METHODS

This study was designed to compare the 'Divide and Conquer' technique with that of the "stop and chop" technique with respect to phaco time and energy required. Incidence of corneal odema, visual outcome and intraoperative and post operative complications.

The work was done on the cases of uncomplicated senile cortical cataract admitted to the Upgraded Department of Ophthalmology, Darbhanga Medical College & Hospital, Laheriasarai, for cataract extraction by phacoemulsification technique.

The 50 patients selected for the study were devided into two groups who underwent phacoemulsification.

A) Group I – 25 eyes were underwent the phaco using the "Divide and Conquer" technique of nucleofracture.

B) Group II – 25 eyes were underwent the phaco using the "stop and chop" technique of nucleofracture.

Exclusion Criteria

The patients with the following conditions were excluded from the study –

1. Age related macular degeneration.
2. Diabetic retinopathy.
3. Hypertensive retinopathy.
4. Glaucoma
5. Retinal detachment.
6. Inadequate pupillary dilation.
7. Hazy/oedematous cornea.
8. Subluxated or dislocated lens.
9. Traumatic or complicated cataract.
10. While cataract and grade IV nucleus.

Selection of type of cataract

Only grade II and III nuclear opacities were taken up in

the study after classifying them by slit lamp method of Jaffe (1990).

Preoperative Evaluation

All patients were subjected to detailed history, systemic examination and complete ocular examination.

1. Complete ocular examination included – Anterior segment and posterior segment examination with the help of torch light, slit lamp, direct and indirect ophthalmoscope.
2. Visual acuity were measured by snellen's chart at a distance of 6 meter unaided and with the glasses.
3. Cornea was examined under slit lamp for the hazy or odematous cornea.
4. Intra-ocular pressure was measured by Goldman applation tonometer at least one day prior to surgery.
5. Grading of nucleus hardness was done by slit lamp method of Jaffe (1990).
6. Keratometry by Baush and Lomb keratometer.
7. A scan was done and IOL-power was calculated by using the SRK-II formula.
8. Pre-operative routine investigations like, fasting and postprandial blood sugar level and routine examination of urine were done.
9. Syringing to exclude daeryocystitis or block in the lacrimal drainage system was done.

Intraoperative Assessment

1. Effective Phaco Time : The duration for which 100% phaco power was used to emulsify the nucleus, was measured with the help of entities on "Display of phaco-machine"

Effective phaco time = Power × Duration

Example: If 60% phacopower is used for 120 sec.

$$\text{Effective phaco time} = \frac{60}{100} \times 120 = 72 \text{ sec.}$$

2. Time in Nucleus management: Time taken to complete the nucleotomy part of phacoemulsification was measured by digital watch.
3. Intra operative complications: Any per operative complication at different stages of nucleus emulsification with these two techniques were recorded.

Post- Operative Assessments

All cases were started with post-operative treatment of

1. Antibiotic- steroid ointment Eye Drops QID × 6 wks.
2. Mydriatic –cycloplegic (Tropac-p) Eye Drops BD × 3 wks.
3. 0.5% Timolol maleate Eye Drops BD × 3 wks.

Post-operative examination was carried out at -

The 1st post operative day.

End of 1st week.

End of 4th week.

End of 3rd month.

Parameters assessed among the three groups on follow-ups

1. Unaided Visual Acuity and corrected visual acuity measured.
2. Examination of cornea under slit lamp, for corneal hazyness, edema and striate keratopathy
3. Anterior chamber for inflammatory reaction (> grade - I) using slit lamp by making 2mm × 1mm oblique slit beam under maximum light intensity and magnification of the slit lamp (KANSKI-2003).
4. Posterior capsular status and status of IOL recording the posterior capsule opacitication; posterior synechiac formation and decentration of IOL.
5. Intraocular pressure measured by Goldman applanation Tonometer at all visits.

Surgical Technique

All the procedures were performed under periocular anesthesia using 2% Lidocaine and 0.5% Bupivacaine. After aseptic cleaning and draping of the eye, a clear corneal phaco-tunnel incision of 3.2 mm was placed temporally with the help of disposable steel keratome and at the same time a side part incision (a small paracentesis limbal incision 1 mm wide, and 0.75 mm long) was created 90 degrees away from the main incision, using a 15-30 degree metal blade (side-port).

Anterior capsulorrhexis was completed with 26 G needle (cystitome) under viscoelastic, which was followed by hydrodissection and hydrodelination.

Two different types of nucleatomy procedures (stop and chop and Divide and Conquer) were randomly used in these eyes undergoing phacoemulsification.

Cortical matter was aspirated using irrigation/aspiration cannula attached to the phaco machine.

A 5.0 mm optic size, single piece PMMA IOL, was implanted "in the bag" in all the cases.

Stop and Chop technique

Central Sculpting: A trench is made in the centre of the nucleus, sculpted deeply and as long as possible.

Broken into two halves: The chopper is placed through the side port incision with the distal tip into the trench. The nucleus is then completely fractured through the posterior plate.

Chopping and Emulsification: The chopping portion of the procedure is begun by rotating the nucleus so that half of it lies across the inferior capsular bag. The phaco tip is buried into the inferior half of the nucleus and is held there with aspiration only. The chopper is then pulled toward the phaco tip, thereby deeply grooving the nucleus. When the chopper reaches the phaco tip, the chopper and tip are separated, this action splits the nuclear rim so that one nuclear piece is completely separated. This piece is held into the phaco tip with

aspiration, followed by emulsification. Similarly the entire nuclear rim is easily removed using the same steps.

During this technique the average parameters on phaco machine were as follow:
During Sculpting-Energy-60% During Emulsification-Energy-50%
Flowrate-18cc/min Flowrate-22cc/min
Vacuum-10 mmHg Vacuum-200mmHg

Divide and Conquer Technique
Trenching: Surgery is initiated by sculpting a trench which should be as deep as possible and about two phaco tips wide so that adequate depth of groove is attained and the two instruments can be placed easily.

After the first trench is made, the nucleus is rotated through 90^0 clock wise with a nucleus rotator/spatula inserted though the side port incision. Another trench is then made in the inferior nucleus similar to the first trench as deep as possible, beginning the process of quartering the nucleus. Similarly, the third and fourth trench is also made by rotating the nucleus through 90^0 clockwise.

Now, the nucleus is converted into four quardrants of inner nucleus separated by a thin bridge of posterior nuclear plate.

Cracking the Nucleus : Phaco tip is placed in the inferior trench and pressed against the left handed wall of the trench. The spatula is inserted through the side port incision, pressed against the right handed wall of the trench, using a cross action, two walls are separated this will crack the posterior plate.

Nucleus is rotated through 90^0 anti clockwise and another separation carried out, causing complete isolation of one quadrant of the nucleus from rest of the nucleus.

Now, with the help of the spatula, the tip of apex of this isolated quardrant of the nucleus is engaged with phaco tip and emulsified.

Thus, one quadrant is emulsified, then nucleus rotated through 90^0 anticlockwise, and in a similar fashion cracking followed by emulsification of that quadrant carried out, causing the removal of the second quadrant of the nucleus. Similarly other two quadrants also removed, completing the nucleotomy part of phacoemulsification.
During this technique the average parameters on phaco machine were as follow
During Sculpting-Energy-60% During Emulsification-Energy-60%

Flowrate-20cc/min
Flowrate-22cc/min
Vacuum-10 mmHg Vacuum-150mmHg

OBSERVATIONS AND RESULTS
50 subjects with IMSC, suitable for phacoemulsification, having age range between 40-80 years were randomly divided into two groups, with 25 eyes in each group.
Group – I – 25 eyes with stop and chop technique.
Group – II – 25 eyes with four quadrant technique.

Student t-test was used for analysis of the data and by calculating p-value significant and non-significant differences were noted between two groups.

Preoperative Parameters
(A) Age Distribution of Patients
Table – I:

Age group	No. of patients	Percentage (%)
40-45 yrs	03	6%
46-50 yrs	07	14%
51-55 yrs	08	16%
56-60 yrs	10	20%
61-65 yrs	12	24%
66-70 yrs	06	12%
71-75 yrs	03	6%
76-80 yrs	01	2%

The maximum patients were between age group of 51 to 65 yrs (60%), irrespective of age patient were divided into two groups for two different nucleotomy techniques.

(B) Sex Distribution
Table-II:

Sex	No. of Patients	Percentage (%)
Male	36	72%
Female	14	28%

Male patients outnumbered (72%) over number of female patients.

Grade of Hardness of nucleus
Table-III:

Nucleus Grade	Stop and Chop	Divide and Conquer
Grade II	9/25	10/25
Grade III	16/25	15/25

Grade III nucleus opacity were found to be maximum (62%). Out of 50 cases 31 cases of Grade III while 19 cases were of Grade II.

The nucleus Hardness was not significantly different among these two groups. ($p>0.05$)

Pre-operative visual acuity
Table-IV:

V/A	No. of patients	Percentage (%)
< 6/60	11	22%
6/60-5/56	35	70%
6/56-6-24	04	8%

Maximum no. of patients were of V/A of 6/60-6/36 (70%) followed by V/A of < 6/60 in (22%) of patients.

Percentage Power used in different techniques
Table-V:

	Power Used			
	>60%	**50-60%**	**40-50%**	**Total**
Stop & Chop				
Grade II	00	03	06	09
Grade III	08	07	01	16
Divide & Conquer				
Grade II	00	02	08	10
Grade III	09	06	00	15

In both the groups more power was consumed for grade III nuclei, with respect to grade II nuclei. However in both nucleotomy techniques there was no statistically significant difference ($p > 0.05$).

Time Consumed in nucleus Management
Table-VI:

Technique of nucleotomy	Average Time
(a) Stop & Chop	6.316 min.
(b) Divide & Conquer	7.46 min.

The average time required in Divide & Conquer technique was more than stop and chop technique. There was no significant difference statistically among the two technique of nucleotomy ($p>0.05$).

Effective Phaco Time
Table-VII:

Nucleotomy Technique	Effective Phaco time
Stop & Chop	26.364 sec.
Divide & Conquer	26.42 sec.

Effective phaco time required in Divide & Conquer technique was more than. Stop & Chop technique. There was no significant difference statistically among the two technique of nucleotomy ($p>0.05$).

Intraoperative Complications
Table-VIII:

	Stop & Chop	Divide & conquer
Ant. Cap. Tear.	2	1
Conversion to ECCE	1	0

Anterior capsular tear was one of the complication during surgery which occurred in two cases of stop & chop group and one case of divide and conquer group. one case was converted into standard extracapsular cataract extraction due to zonular dialysis in stop and chop group, which was excluded out of the study.

Post Operative Parameters
Stop and chop group (post-op visual acuity)
Table – IX:

	□6/9	6/12-6/36	<6/36
1st day	15 (60%)	10 (40%)	0 (%)
1 week	18 (72%)	07 (28%)	0 (%)
4 week	22 (88%)	03 (12%)	0 (%)
3 months	24 (96%)	1 (4%)	0 (%)

Divide and conquer group (post-op. visual acuity)
Table-X:

	□6/9	6/12-6/36	<6/36
1st day	17 (68%)	8 (32%)	0 (0%)
1 week	21 (84%)	4 (16%)	0 (0%)
4 week	25 (100%)	0 (0%)	0 (0%)
3 months	25 (100%)	0 (0%)	0 (0%)

The Post-op visual acuity on first post operative day >6/9 in 15 cases and < 6/9 in 10 cases stop and chop and > 6/9 in 17 cases and < 6/9 in 8 cases four divide and conquer group. It is not statistically significant among the two groups.

By the end of the study, all the patients in all two groups had the visual acuity of 6/9 or better.

Post Operative complications
Central corneal edema
Table – XI:

Techniques of Nucleotomy	Incidence of Corneal edema
Stop and Chop	3/25
Divide and Conquer	2/25

NS (Nothing significant $p > 0.05$).

Incidence of central edema was found in 8%. 3 cases (12%) in stop and chop group and 2 cases (8%) in divide and conquer group. It was not statistically significant among the two groups.

Post-op anterior uveitis
Table – XII:

Techniques of Nucleotomy	Cases of Anterior uveitis
Stop and Chop	1/25
Divide and Conquer	Nil

NS (Nothing significant p > 0.05)
One case had postoperative anterior uveitis in stop and chop group.

Posterior capsular and IOL status
1. There was no posterior capsular opacification was detected in any of the two groups.
2. IOL was found to be centered in all the two groups on all follow-ups.
3. In all the two groups, no posterior synechiae formation detected on all follow ups.

DISCUSSION

The goal of modern cataract surgery is to produce a pseudophakic eye with the quality of vision of an emmetropic phakic eye. The presence of sutures and the subsequent induced astigmatism in the extracapsular technique are major obstacles to early visual rehabilitation.

A revolution in cataract surgery occurred with the development of phaco by Charles Kelman in 1960s. Kelman (1967) introduced the technique of phacoemulsification. It is now a safe and effective procedure for early rehabilitation in cataract patients.

H. Gimbel (1985) developed the 'radial fracturing' technique of nucleus emulsification to make phacoemulsification within the capsular bag more efficient. Since then various techniques of necleotomies are described in the literature.

Different standard nucleotomy techniques are
1. Chip and Flip (L.H. 1989)
2. Divide and Conquer (Gimbel 1985)
3. Stop and Chop (Koch and Katzen 1994)
4. Phaco Chop (K. Nagahara 1993)
5. Four Quadrant (John Shephered, 1990).

In view of no prospective studies to compare efficacy and results of two standard nucleotomy techniques (stop & chop and divide & conquer technique), we have endevoured to compare these two techniques of nucleotomy in this study.
50 cases of age and sex matched IMSC were randomly divided into two groups.
Group I: 25 eyes with stop and chop technique
Group II: 25 eyes with divide and conquer technique.

Pre-operative parameters
Age – The maximum patients were between the age group of 51 yrs-65 yrs (60%), followed by age group of 66 yrs-75 yrs (16%). The least common age group was 76 yrs-80 yrs. (2%).

Sex – In our study more number of male patients (72%) underwent the phaco surgery as compaired to the female patients (28%).

Nuclear Hardness
Grade III nuclear opacity were found to be maximum (62%), out of 50 cases 31 cases were of Grade III while 19 cases were of Grade II.

There was not statistically significant difference among the two groups(p>0.05)

Intra-operative parameters
Percentage power used in two Technique

In both the groups more power was consumed for grade III nuclei with respect to grade II nuclei, however in both nucleotomy techniques there was no statistically significant difference (p>0.05)
Average-Time consumed in nucleus management.

The average time required in divide and conquer technique (7.46 min) was more than stop and chop technique (6.316 min.). There was no statistically significant difference among the two techniques of nucleotomy (p > 0.05).
Effective Phaco time

Effective phaco time required in divide and conquer technique was (26.42 sec.) more than stop and chop technique (26.364 sec.). There was no statistically significant difference among the two techniques of nucleotomy (p>0.05).

The corroborates with the report of pirazzoli. G et al (1996).

Intra-operative complications
Anterior capsular tear was one of the complication during surgery which occurred in 2 cases of stop and chop group and 1 case in divide and conquer group. One case was **converted into standard ECCE** due to Zonular dialysis in divide and conquer technique which was excluded out of the study.

Post-operative parameters
- Post operative visual acuity

The Post oprative visual acuity on the first post op day was > 6/9 in 15 cases and < 6/9 in 10 cases in stop and chop and >6/9 in 17 cases and <6/9 in 8 cases. It is not statistically significant among the two groups.

By the end of the study, all the patients in two groups had the visual outcome (visual acuity) of 6/9 or better. This is in consonance with the report of Cruh OA et al (1992), Frances et al (1993).

- Post-operative complications
- Incidence of corneal oedema was found in 3 cases (12%) in stop and chop group and 2 cases (8%) in divide and conquer Group. It was not statistically significant among the two groups ($p>0.05$).
- One case had post-operative anterior uveitis in stop and chop group. This corroborates the study of Oshika. T. et al (1992).
- There was no posterior capsular opacification was detected in any of the two group.
- IOL were found to be centered in two group on all followups.
- In two groups, no posterior synechiac formation detected on all follow-ups.
- Some documented studies that support our study are as follows.

DeBry P et al (1998) Reported a study comparing mean phacoenergy used in phaco chop and four quadrant technique. Mean phaco power in these two techniques were 782±446 J in Phaco chop and 3264±1218 J in four quad. Phaco was significantly better in terms of less phaco energy used compared to four quadrant technique (p value 0.00001).

Kohlhass M et al (1988) Reported endothelial cell loss(corneal edema) of 15% in divide and conquer technique of nuclectomy.

Pirazzoli G et al (1996) Presented effects of phaco time on corneal endothelium using phaco chop technique. He found endothelial cell loss of 4.72±1.2% with mean phaco time of 25.33±11.26 sec. These studies show that endothelial cells loss in less with phaco chop technique. A cell loss of 26%, 15% and 12% in anterior chamber phaco, posterior chamber phaco and standard extracapsular cataract extraction respectively was reported by Graether (1983).

Arensten et al (1997) Reported that direct contact of the probe with the endothelium appears to be one of the most significant factors producing permanent endothelial damage. Phacoemulsification was not popular initially as it produced excessive loss of endothelial cells (Jaffe, 1990).

Dick B et al (Ophthalmologe, 1975) Described a relationship between ultrasound time (UT) and endothelial cell loss (ECL).

Endothelial cell loss decreased from 6.3% in first post operative week to 5.4% six months post operative, operated under UT < 1 minute 30 seconds (10 patients), from 8.1% to 7.0% operated under UT of 1 min 31 sec to 2 min 30 sec (14 patients), and from 11.2% to 10.4% under UT of 2 min 31 sec to 3 min 30 sec (7 patients).

Conclusion: They reported ECL of 7.3% at the end of 6 months and found that there is a direct linear relationship between ultrasound time and endothelial cell loss.

Zetterstrom C et al (J-Cat-Ref Surg; 1995 January) Reported a mean endothelial cell loss of 4% and found central corneal thickness was the same as it had been preoperatively, at the end of three months of phacoemulsification.

Hayashi K et al (J Cat Ref. Surg., 1994 Jan) They assessed corneal endothelial damage in phaco surgery, using four quadrant nuclear cracking technique; in comparison to phaco surgery using undivided sculpting technique. They reported ultrasound time was shortened using the nuclear cracking technique and resulted in less corneal injury.

Cruz OA et al (Ophthalmology, 1992 Mar) The analysed the visual outcome and incidence of complications in 181 cases of phaco, and reported the overall incidence of posterior capsule rupture was 9.9% and final best corrected visual acuity of 20/40 or better was obtained in 92.6% of eyes.

Gimbel HV (J Cat Ref Surg, 1991 May) Described a new technique for nucleus management in phacoemulsification. He divided the nucleus into fragments by manual cracking followed by emulsification of the fragments, the technique called, "Divide and Conquer". This technique allows phacoemulsification to be extended to patients with hypermature and brunescent lenses.

Westcott MC, Tuft SJ and Minassian studied in Moorfields Eye Hospital, London between 1996 and 1999, there were 742 eyes with no comorbidity undergoing surgery; 96% of procedures were by phacoemulsification and two thirds of the cases were performed by residents. 66 (8.9%) of total 742 eyes with no comorbidity had surgical complications. 1.5% had posterior capsule rupture without vitrectomy, and there were an additional 3% with posterior capsule rupture and anterior vitrectomy.

CONCLUSIONS

The salient features of our study were

1. The age group of 51-65 yrs. (60%) were underwent the phaco with these two nucleotomy technique as compaired to other age group.
2. 72% of the male patient were underwent the phacosurgery as compaired to 28% of the female patients.
3. Grade III nuclear opacity were found to be maximum (62%).
4. Effective phaco power used in divide and conquer (27.3 sec) was more than the power used in stop and chop (25.2 sec) which was not significantly different.
5. The average time consumed in nucleus management in divide and conquer technique (8.0 min.) was more than in stop and chop technique (6.44 min) which was not statistically significant difference.
6. Anterior capsular tear occurred in 2 cases of stop &

chop group and 1 case in divide & conquer group. One case in stop & chop group. converted into ECCE due to Zonular Dialysis, this case was excluded out of study.

7. There was no significant difference in post-op visual acuity among the two group at any of the follow-ups.
8. There was no posterior capsular opacification detected in any of the two groups.
9. IOLs was found to be centered in two groups on all follow-ups.
10. In two groups, no posterior synechiae formation detected on all follow ups.
11. Incidence of central corneal edema was 3 cases (12%) in stop & chop and 2 cases (8%) in divide & conquer group.
12. One case had post operative anterior uveitis in stop &chop group.

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