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Tarek Ibrahim Badr
Department of ophthalmology, Memorial Institute for ophthalmic research, Cairo, Egypt,
tarekbadr613@hotmail.com

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ORIGINAL STUDY

The effect of different types of phacoemulsification surgery on the postoperative visual acuity

Tarek Badr*

Ophthalmology Department, Memorial Institute for Ophthalmic Research, Cairo, Egypt

Abstract

Background: **The most popular cataract surgery method in the world is phacoemulsification surgery. There are two kinds of phacoemulsification: longitudinal and torsional. Our research compares the impact of longitudinal and torsional phacoemulsification on postoperative visual acuity.**

Patients and methods: **We will compare the postoperative best-corrected visual acuity after torsional phacoemulsification against longitudinal phacoemulsification in our prospective randomized trial. A total of 50 eyes having cataract of nuclear shape ranging in grade from grade 1 to grade 3 going to be involved in our study.**

Results: **Regarding postoperative visual acuity, the *P* value between torsional phaco and longitudinal phaco was 0.557 (>0.05), indicating no significant difference statistically between the two types.**

Conclusion: **We concluded that both phacoemulsification techniques are safe and successful after comparing the two types and discovering no statistically significant difference in postoperative best-corrected visual acuity.**

Keywords: Longitudinal, Phacoemulsification, Torsional, Visual acuity

1. Introduction

It was considered to be extremely hard to eliminate a cataract through a 3 mm incision in the 1960s. Completing the 'impossible' necessitated reconciling inconsistencies, which was achieved through the wise utilization of novel technologies. Dr. Charles Kelman created phacoemulsification after a dental appointment when his teeth were cleaned with ultrasonic energy. But to turn inspiration into reality, a tremendous deal of resourcefulness and persistence were required. History showed how creativity, bioengineering, and surgical technology came together to make phacoemulsification a practical technique for cataract extraction. But 35 years ago, there were no IOLs accessible, and Kelman was the only one doing lens emulsification. Kelman phacoemulsification is currently used in most of the cataract procedures conducted in America. The journey from there to here in thirty-five years required the fusion of industrial technology and surgical technique into a 'surgical industrial complex.' A modern marvel of sight restoration that is incredibly affordable has emerged, helping many elderly patients to continue living independently [1].

Present phacoemulsification procedures for cataract surgery provide a variety of appealing advantages for patients and surgeons, especially with the introduction of foldable intraocular lenses [2].

Two basic components can be used to define phacoemulsification surgery. First, the nucleus is emulsified using ultrasonic energy. Second, the anterior chamber is preserved while it is removed via a tiny incision using a fluidic circuit. Elevation of the irrigation bottle provides the fluid volume and pressure needed to keep the anterior chamber of the eye hydrodynamically and hydrostatically, respectively, for this circuit; the pressure in the anterior chamber is directly correlated with the bottle's height. The pump that controls the fluid circuit not only removes emulsion from the chamber but also has a great deal of therapeutic use. Nuclear fragments are drawn to the anterior chamber by the pump's currents, which are measured in cubic

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* Postal code: 13512, Egypt.
E-mail address: tarekbadr613@hotmail.com.

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centimeters, or milliliters, per minute, when the phaco tip is unoccluded. The machine pump delivers holding strength, or vacuum, which binds the fragment when it completely occludes the tip. The surgeon needs to comprehend the reasoning behind determining the parameters of ultrasonic power, vacuum, flow, and bottle height to effectively utilize the capabilities of a phaco machine [3].

The amount of power required to emulsify the cataract has decreased thanks to vacuum-assisted phaco, interrupted phaco modes, and enhanced pump systems. However, because ultrasonic power still carries the risk of endothelial cell death and tissue injury, the primary goals of phacoemulsification technology are to reduce ultrasonic power and increase its efficiency [4].

Only during forward strokes does longitudinal phacoemulsification function in a longitudinal stroke direction, cutting only when necessary. This longitudinal approach reduces repulsion by creating heat that is proportionate to the phaco power used [5].

In addition to requiring less power compared with the longitudinal technique and having superior efficacy and phaco time, torsional phacoemulsification acts by sideways with a cutting action in both right and left directions. Additionally, the torsional type has superior followability, less repulsion, and less dispersion of lens matter, which allows us to decrease the vacuum, as well as stability of anterior chamber, or less surge [5].

Table 1 Comparison between longitudinal and torsional phaco [6].

In contrast to longitudinal phacoemulsification machines, torsional machines have better followability, less chatter, and a lower mean needle time. This was correlated with improved visual acuity and decreased corneal edema one day after surgery [7].

Following cataract surgery, there may be variable degrees of endothelial cell loss contingent on the use of more advanced surgical technologies such as viscoelastic devices and torsional ultrasonography, as well as factors of the patient's previous medical history. Furthermore, torsional phacoemulsification has a higher efficacy in reducing corneal endothelium loss while generating less heat energy and repulsion [8].

According to a 2014 study by Amrita *et al.* patients who had torsional phaco lost considerably less corneal endothelial cells (8.1%) than those who had longitudinal phaco (10.78%). The mean best-corrected visual acuity (BCVA) on postoperative day 30 improved significantly more in the torsional group than in the longitudinal group when compared with the baseline mean BCVA, according to the results [9].

2. Patients and methods

2.1. Time frame

This study was carried out in January 2022–January 2023. The study process was accepted by our hospital's Review Board. Before any data was collected, formal permits and administrative consent were obtained. Study participants gave their informed consent on the promise of data privacy.

2.2. Study population

The Memorial Institute for Ophthalmic Research (MIOR), an outpatient ophthalmology clinic, saw 50 consecutive patients who met the study's eligibility requirements.

2.3. Inclusion criteria

(a) Mature or immature involutional cataract.
(b) Clear cornea.
(c) Dilatable pupil.
(d) Normal depth of anterior chamber.
(e) No eye disease or inflammation.

2.4. Exclusion criteria

(a) History of ocular surgeries.
(b) Presence of any type of corneal opacities.
(c) Glaucomatous patients.
(d) Patients having hypermature senile cataracts.
(e) Pseudoexfoliative patients.

Table 1. Shows a comparison between longitudinal and torsional phaco.

Comparison	US/Neo Phaco	Torsional
Frequency	40 KHz	32 KHz
Max stroke	85 um	85 um
Stroke direction	Longitudinal	Sideways
Preferred mode	Pulse/Burst	Continuous
Cutting action	During forward stroke only	During either the left or right direction
Vacuum needs	Benefits from high vacuum to reduce repulsion	A medium vacuum is sufficient to pull material through
Repulsion	Mitigated by vacuum and pulse/burst	Intrinsically not present
Heat	Proportional to power	Proportional to amplitude but 2/3 less than in phaco

2.5. Methods

In our prospective randomized experiment, we contrasted the visual acuity following longitudinal and torsional phacoemulsification. A total of 50 eyes with cataracts of nuclear type, grades 1 through 3 were included in our investigation. The age range of the patients was 50–70 years old. Using the Divide and Conquer strategy, phacoemulsification was carried out using a (Infiniti, Alcon) machine. The cases were split into two groups:

= Group (A) consisted of 25 eyes that had torsional phacoemulsification cataract surgery. =Twenty-five eyes in group (B) had longitudinal phacoemulsification cataract surgery.

2.6. Preoperative assessment

(a) Examination using a slit lamp (Haag Striet slit lamp).
(b) Visual acuity evaluation.

= Specular microscopy to evaluate central endothelial count.

(c) Comprehensive preoperative evaluation, comprising intraocular pressure measurement (applanation tonometer), fundus inspection (Volk 90 D lens), and intraocular lens power computation.

2.7. Operative procedure

Tropicam 1%, cyclopentolate 1%, and phenylephrine 10% were used to induce mydriasis. Bupivacaine 0.5% was combined with 2% lidocaine to provide peribulbar anesthesia. Povidone-iodine was used to cleanse the conjunctival sac. At 11 o'clock, a clear cornea incision was done using a 2.2 mm keratome. Injection of 1% sodium hyaluronate (Healon) into the anterior chamber. A capsulorrhexis forceps was used to proceed with the capsulorrhexis. There were two side ports completed at 3 and 9 o'clock. The rotation of the nucleus was used for both hydrodissection and hydrodelineation. The Infiniti, Ozil technology, Alcon phaco machine was used to accomplish phacoemulsification, and a Kelman 30° beveled phaco tip was used.

For torsional situations, continuous mode was employed with the following parameters during sculpting (phaco 1): 80 cmH_2O bottle height, 23 ml/min flow rate, 50 mmHg vacuum, and 80% power. Phcoemulsification (phaco 2): 60% power, bottle height of 100 cmH_2O, flow rate of 28 ml/min, and vacuum of 300 mmHg. In longitudinal cases, pulse mode was employed; other parameters remained the same as the torsional group, but phaco power dropped to 60% during sculpting (phaco 1) and 40% during phacoemulsification (phaco 2).

The divide and conquer strategy was applied, and after the cortex was removed using a bimanual Irrigation/Aspiration, Healon was injected once more into the anterior chamber and capsular bag. To implant a foldable acrylic hydrophilic one-piece IOL (Eyecryl) in the capsular bag, the corneal tunnel is extended to a diameter of 3 mm. The bimanual I/A was used to aspirate the Healon, and stromal hydration was used to close the side ports and corneal tunnel. After the procedure, subconjunctival injections of dexamethasone and gentamicin were administered. Following surgery, our patients used 1% prednisolone and 0.3% ofloxacin eye drops five times a day.

2.8. Postoperative plan for follow-up

Following surgery, all patients in both groups were measured for visual acuity at 1 day, 1 week, 1 month, and 3 months. The postoperative visual acuity was compared with the preoperative visual acuity. Specular microscopy was done at 1 month postoperative comparing it with the preoperative specular microscopy.

2.9. Statistical analysis

The data was collected, processed, coded, tabulated, and analyzed using the Statistical Package for the Social Sciences (IBM Corp., 2011). 20th edition of IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp. To display qualitative data, numbers, and percentages are utilized. The median and interquartile range are used for nonparametric quantitative data, and the mean, standard deviation, and ranges are used for quantitative data with a parametric distribution. To compare the two groups before and after quantification, a paired *t*-test was employed in addition to parametric data distribution. The Wilcoxon rank test was utilized to compare the two groups, with quantification applied prior to and following the nonparametric distribution. There was a 95% confidence interval and an estimated 5% margin of error. *P* values below 0.05 are therefore suggestive. *P* values less than 0.05 are therefore indicative of significance.

3. Results

A total of 50 eyeballs underwent phacoemulsification; 25 of them underwent torsional

Table 2. Comparison between torsional phaco and longitudinal phaco according to sex.

	Torsional phaco *N* (%)	Longitudinal phaco *N* (%)	Total *N* (%)	X^2 test	*P* value
Male	10 (40.0)	13 (52.0)	23 (46.0)	0.725	0.395 NS
Female	15 (60.0)	12 (48.0)	27 (54.0)		
Total	25 (100)	25 (100)	50 (100)		

phacoemulsification, while the remaining 25 underwent longitudinal phacoemulsification in a randomized fashion. Table 2, Chart 1 and 2 show that 27 (54%) of patients were female and 23 (46%) of cases were male. Table 3 and Chart 3 show that the age range was 52–70 years in the torsional group, with a mean age of 60.6 ± 4.57, and 50–70 years in the longitudinal group, with a mean age of 61.48 ± 6.12.

Tables 4 and 5 and Chart 4 and 5 illustrate the relationship between the visual acuity, preoperative and postoperative, in torsional phaco against longitudinal phaco. Regarding preoperative visual acuity, when torsional phaco and longitudinal phaco were compared, the *P* value was 0.474 (>0.05), indicating that there was no statistically significant difference between the two groups. Regarding postoperative visual acuity, when torsional phaco and longitudinal phaco were compared, the *P* value was 0.557 (>0.05), indicating that there was no statistically significant difference between the two groups.

Finally, we calculated the percentage of endothelial loss in each group Table 6 and Chart 6.

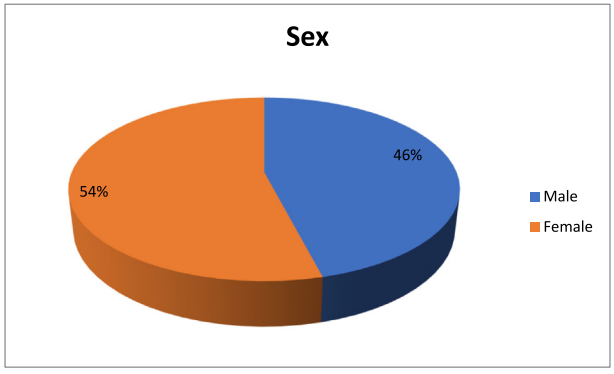

Chart 1. Represents the ratio of males to females in the study.

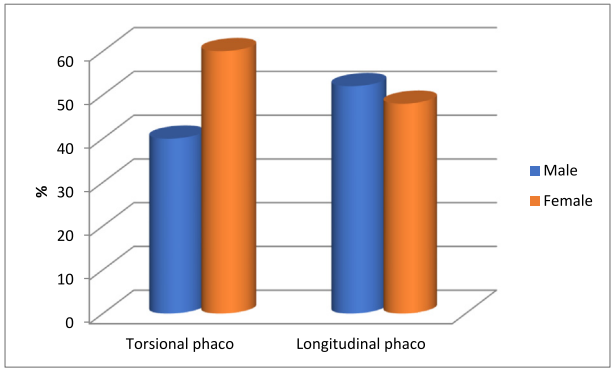

Chart 2. Represent sex distribution in both groups.

4. Discussion

These days, the goal of cataract surgery is to produce the best possible uncorrected eyesight following the procedure, rather than just removing the cataractous lens. This is due to advancements in the field. Additionally, the overall safety of the process has been increased by recent technological advancements in surgical procedures and instruments, which encourages surgeons and even patients to proceed with surgery earlier [10].

Visual symptoms including starbursts, night glare, and halos are typical after simple surgery, especially with high-quality intraocular lenses. These symptoms might occasionally make patients unhappy after surgery [11].

The results of cataract surgery may be negatively impacted by intraoperative problems (such as iris damage, posterior capsular breach, or zonular dialysis) or postoperative complications (such as retinal breaks, especially in long eyes, posterior capsule opacification, cystoid macular edema) [12].

Poorer visual acuity results are independently correlated with aging, vitreous loss, and iris damage. Growing older could be a proxy for various ocular illnesses that already exist and could impact early post-operative visual acuity, such as ++ IOP, age-related macular degeneration, and early corneal endothelium failure [13].

Additionally, the vitreous loss has been linked to lower visual acuity results and early postoperative problems from cataract surgery, such as intraocular lens displacement and macular edema [14].

The lack of a direct correlation between posterior capsule rupture and lower postoperative visual acuity highlights the significance of appropriately managing this complication to reduce the risk of vitreous loss. Similarly, it was discovered that iris trauma was linked to worse outcomes. This finding may be explained by a higher incidence of postoperative macular edema and a higher risk of postoperative inflammation [15].

Table 3. Comparison of age between torsional phaco and longitudinal Phaco.

Variable	Groups	Torsional phaco	Longitudinal phaco	Student *t*-test	*P* value
Age	Mean ± SD Range	60.6 ± 4.57 52–70	61.48 ± 6.12 50–70	0.576	0.567 NS

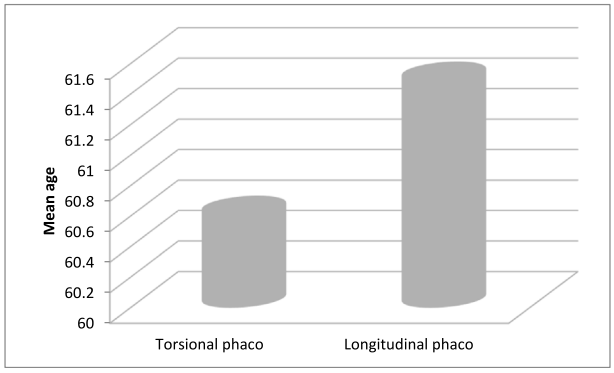

Chart 3. Mean age in torsional and longitudinal phaco.

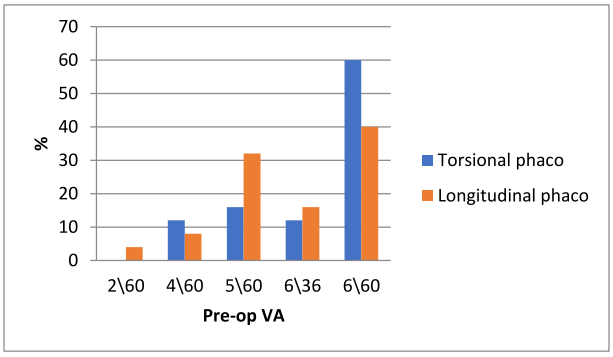

Chart 4. Correlation between torsional phaco and longitudinal phaco according to preoperative V/A.

According to a study by Amrita *et al.*, torsional phacoemulsification considerably outperforms longitudinal phacoemulsification in terms of improving mean BCVA on postoperative day 30 relative to baseline mean BCVA [9]. This is not the case with our study, which demonstrated no discernible variation in BCVA between the two groups.

Torsional Phaco offers less Phaco time and so less heat production plus better followability, the findings of our investigation demonstrated that torsional phacoemulsification is better than Longitudinal type regarding postoperative BCVA and endothelial loss, but the difference between the two types was not

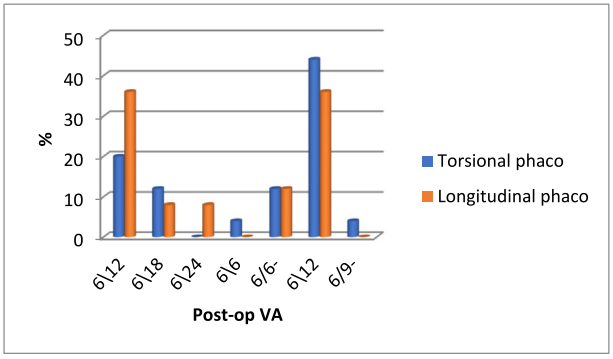

Chart 5. Correlation between torsional phaco and longitudinal phaco according to postoperative V/A.

Table 4. Comparison between torsional phaco and longitudinal phaco according to preoperative V/A.

Preop V/A	Torsional phaco *N* (%)	Longitudinal Phaco *N* (%)	Total *N* (%)	FET	*P* value
2/60	0	1 (4.0)	1 (2.0)	3.66	0.474 NS
4/60	3 (12.0)	2 (8.0)	5 (10.0)		
5/60	4 (16.0)	8 (32.0)	12 (24.0)		
6/60	15 (60.0)	10 (40.0)	25 (50.0)		
6/36	3 (12.0)	4 (16.0)	7 (14.0)		
Total	25 (100)	25 (100)	50 (100)		

Table 5. Comparison between torsional phaco and longitudinal phaco according to postoperative V/A.

Postop V/A	Torsional phaco *N* (%)	Longitudinal phaco *N* (%)	Total *N* (%)	FET	*P* value
6/24	0	2 (8.0)	2 (4.0)	6.1	0.557 NS
6/18	3 (12.0)	2 (8.0)	5 (10.0)		
6/12	5 (20.0)	9 (36.0)	14 (28.0)		
6/9	2 (8.0)	0	2 (4.0)		
6/9	11 (44.0)	9 (36.0)	20 (40.0)		
6/6-	3 (12.0)	3 (12.0)	6 (12.0)		
6/6	1 (4.0)	0	1 (2.0)		
Total	25 (100)	25 (100)	50 (100)		

Table 6. Comparison of longitudinal and torsional phaco in terms of endothelium loss percentage.

Variable	Groups	Torsional Phaco	Longitudinal Phaco	Student *t*-test	*P* value
% of endothelial loss	Mean ± SD Range	15.1 ± 2.49 9.62–20.8	16.33 ± 2.52 11.51–20.34	1,73	0.09 NS

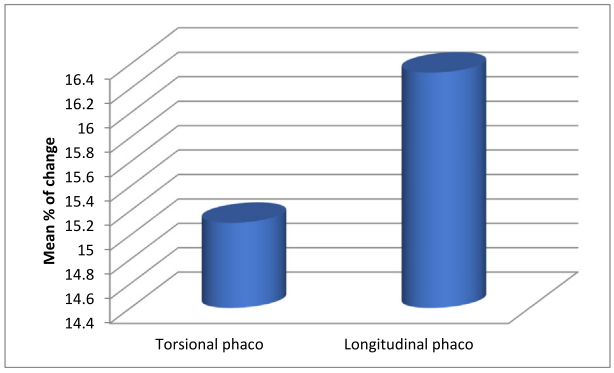

Chart 6. Correlation between longitudinal and torsional phaco, based on the percentage of endothelium loss.

statistically significant. Also, both types of phacoemulsification, torsional and longitudinal, are safe procedures on corneal endothelium and both types showed no statistically significant difference in their effect on endothelial cell density and cell loss postoperatively, Therefore, the surgeon's experience will determine which category of phaco torsional or longitudinal to employ.

4.1. Conclusion

The most popular surgical procedure performed in ophthalmology departments worldwide is cataract extraction. When performed by experienced surgeons, both longitudinal and torsional phacoemulsification procedures yielded satisfactory visual outcomes. We examined the two phacoemulsification techniques in terms of postoperative visual acuity and postoperative endothelial loss, the longitudinal type offers less repulsion, less surge, and less heat production with superior results regarding endothelial loss and visual acuity, however, there was statistically insignificant differences, suggesting that both techniques are similar and that each surgeon can choose their preferred phacoemulsification approach.

4.2. Recommendations

The type of phacoemulsification to be utilized depends on the experience of the surgeon because both torsional and longitudinal phacoemulsification are safe procedures in terms of postoperative visual acuity. Multicenter randomized trials comparing the two forms of Phaco in terms of other parameters including corneal thickness ought to be carried out.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Ethical aspects

Written informed consent will be provided by each patient before inclusion in the study.

Responsibilities

Dr.Tarek Ibrahim Badr is responsible for the study and that the ethical aspects are followed.

Institutional review board (IRB) approval number

IOP00075.

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