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The central corneal thickness (pachymetry) changes following uneventful Phacoemulsification surgeries

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ORIGINAL STUDY

The central corneal thickness (pachymetry) changes following uneventful phacoemulsification surgeries

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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 changes in central corneal thickness (pachymetry) after longitudinal and torsional phacoemulsification.**

Patients and methods: **In this prospective randomized trial, we will assess the changes in pachymetry following torsional versus longitudinal phacoemulsification. Our study will comprise 50 eyes with nuclear cataracts ranging in severity from grade 1 to grade 3.**

Results: **Comparing postoperative pachymetry modifications between torsional phaco and longitudinal phaco revealed no statistically significant difference between the two groups.**

Conclusion: **We concluded that both phacoemulsification techniques are safe procedures after comparing the two types and finding no statistically significant difference in postoperative Pachymetry alterations.**

Keywords: Longitudinal, Pachymetry, Phacoemulsification, Torsional

1. Introduction

Surgery for cataract extraction was revolutionized with the development of the phacoemulsification procedure. Dr. Charles Kelman innovated this while visiting the dentist; he got the idea for it then. The fundamental idea behind phacoemulsification was inspired by his observations of the use of ultrasound energy for teeth cleaning and his contemplation of applying the same energy for cataract extraction. These days, the phacoemulsification procedure is used in over 90% of cataract surgeries performed in the US and around the globe (Agarwal *et al.*) [1].

Have-day phacoemulsification procedures for cataract surgery have several appealing advantages for patients and surgeons, especially with the introduction of foldable intraocular lenses (Leaming, 1995) [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. The fluid volume and pressure required to sustain the chamber hydrodynamically and hydrostatically for this circuit are provided by a raised irrigation bottle; the height of the bottle directly affects the anterior chamber pressure. A pump that both removes emulsion from the chamber and has substantial therapeutic value controls the fluid circuit. The pump's currents, which are expressed in cubic centimeters, or milliliters, per minute when the phaco tip is unoccluded, pull nuclear fragments toward the anterior chamber. When the fragment fully occludes the tip, the pump's holding strength, or vacuum (measured in millimeters of Mercury, or mmHg), binds it. To fully maximize the potential of a phaco machine, the surgeon must understand the rationale behind establishing the four critical points: ultrasonic power, vacuum, flow, and bottle height (Agarwal *et al.* 'b') [3].

The amount of energy required to remove the cataract has decreased thanks to vacuum-assisted phaco, interrupted phaco modes, and enhanced pump systems. However, the main goals of

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phacoemulsification technology are to reduce ultrasonic power and increase its efficiency because there is still a risk of endothelial cell loss and tissue injury from ultrasound power (Hoffman *et al.*) [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 (Liu *et al.*) [5].

Torsional phacoemulsification acts sideways, cutting in both left and right directions, and using less power than the longitudinal technique while providing improved efficacy and phaco time. Furthermore, the torsional technique allows us to decrease the vacuum and increase anterior chamber stability, or less surge, because it has greater followability, less repulsion, and less dispersion of lens matter (Liu *et al.*) [5].

Table 1: comparison between longitudinal and torsional phaco (Berdahl *et al.*) [6].

The assessment of corneal thickness is a sensitive way to identify endothelial dysfunction, which ultimately leads to corneal edema. Therefore, we can investigate changes in endothelial function in vivo by doing follow-up studies of the thickness alterations. The two techniques for measuring corneal thickness are ultrasonic and optical pachymetry. The average thickness of a normal cornea is typically 0.52 mm, with a uniform central area measuring approximately 3 mm in diameter. The thickness rises to around 0.63−0.66 mm near the perimeter (Mishima) [7].

In contrast to longitudinal phacoemulsification machines, torsional machines have better followability, less chatter, and a lower mean needle time. This resulted in improved visual acuity and decreased corneal edema (less corneal thickness) 1 day after surgery (Panos *et al.*) [8].

There may be varying degrees of endothelial cell loss following cataract surgery due to advancements in surgical techniques, the use of newer surgical technologies like torsional ultrasound and viscoelastic devices, and factors related to the patients' prior medical history. Additionally, torsional phacoemulsification offers less repulsion and less heat energy generation with higher efficacy decreasing corneal endothelial loss decreasing corneal edema and maintaining the corneal thickness within its normal average (Rosado and Natalie) [9].

2. Patients and methods

2.1. Time frame

The research period for this study was January 2023−2024. Our hospital's Institutional Review Board approved the study to be conducted. Before any data was collected, official permits and administrative consent were obtained. Participants in the study gave their informed consent while being assured of the privacy of their data.

2.2. Study population

A total of 50 patients who met the qualifying requirements for the study were seen at Memorial Institute for Ophthalmic Research, an outpatient ophthalmology clinic. A total of fifty patients who met the qualifying requirements for the study were seen at Memorial Institute for Ophthalmic Research, an outpatient ophthalmology clinic.

2.3. Inclusion criteria

(a) Age-related cataracts, both immature and adult.
(b) A clear cornea free of signs of prior illness.
(c) Normal anterior chamber depth; dilatable pupil.
(d) No inflammation or eye disease locally.

2.4. Exclusion criteria

(a) Past medical history of eye surgery.
(b) The presence of corneal opacities of any kind.
(c) People with glaucoma.

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

Comparison	US/Neo Phaco	Torsional
Frequency	40 KHz	32 KHz
Maximum stroke	85 um	85 um
Stroke direction	Longitudinal	Sideways
Preferred mode	Pulse/Burst	Continuous
Cutting action	During forward stroke only	During either left or right direction
Vacuum needs	Benefits from high vacuum to reduce repulsion	A medium vacuum is enough to pull matter 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

(d) Individuals with cataracts associated to hypermature aging.
(e) Materials for pseudoexfoliation.

2.5. Methods

In our prospective randomized experiment, we contrasted the corneal thickness (pachymetry) following longitudinal phacoemulsification with torsional phacoemulsification. Total 50 eyes with nuclear cataracts of 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 an (Infiniti, Ozil technology, Alcon) phaco machine.

Two sets of cases were created: group (A) included 25 eyes that underwent torsional phacoemulsification cataract surgery, and group (B) included 25 eyes that underwent longitudinal phacoemulsification cataract surgery. Preoperative assessment:

(a) Examination using a Hag Striet slit lamp.
(b) Using an ultrasonic pachymeter (Pacline Optikon, Italy) to measure corneal thickness (pachymetry).
(c) Comprehensive preoperative evaluation, comprising intraocular pressure measurement (applanation tonometer), fundus inspection (Volk 90 lens), and intraocular lens power computation (SRK-T formula).

2.5.1. 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 corneal incision was made 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.

The following settings were used during sculpting (phase 1) in torsional cases: 80% power, 80 cm H_2O bottle height, 24 ml/min flow rate, and 50 mmHg vacuum. Continuous mode was also employed. Phcoemulsification (phase 2): 60% power, bottle height of 100 cmH_2O, the flow rate of 28 ml/min, and vacuum of 300 mmHg for the vacuum.

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 technique, Healon was injected once more into the anterior chamber and capsular bag. To implant a foldable acrylic single-piece IOL (Hexavision) inside 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, the patients used 1% prednisolone and 0.3% ofloxacin eyedrops five times a day.

2.5.2. Postoperative follow-up plan

Following surgery, all patients in both groups were monitored for 1 day, 1 week, 1 month, and 3 months. The postoperative pachymetry was measured and compared with the preoperative pachymetry.

2.6. 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 before and following the nonparametric distribution. There was a 95% confidence interval and an estimated 5% margin of error. Hence, importance is indicated by *P* values less than 0.05.

3. Results

Total 50 eyeballs underwent phacoemulsification; 25 of them underwent torsional phacoemulsification, while the remaining 25 underwent longitudinal phacoemulsification in a randomized fashion.

Table 2. Correlation between torsional phaco and longitudinal Phaco regarding sex.

	Torsional phaco *N* (%)	Longitudinal Phaco *N* (%)	Total *N* (%)	X2 test	*P* value
Male	10 (40.0)	13 (52.0)	23 (46.0)		
Female	15 (60.0)	12 (48.0)	27 (54.0)	0.725	0.395 NS
Total	25 (100)	25 (100)	50 (100)		

Table 2, Charts 1 and 2 show that 54% of patients (27 cases) were female and 46% of cases (23 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.

The normal corneal thickness is around 500 um. In this comparison we compared between the central corneal thickness (CCT) in torsional versus longitudinal phaco, Table 4 and Chart 4 express this relation.

In torsional phaco, the mean preoperative CCT (Pachymetry) is 541.800 um, with a standard deviation of 49.576. 3 months later, the average was 535.280 um, with a standard deviation of±42.886.

Preoperatively, the longitudinal phaco mean CCT (Pachymetry) is 542.400 um, with a standard deviation of 47.349. 3 months later, the mean value was 544.480 um, with a standard deviation of±35.936.

There was no statistically significant difference between the two forms of surgery when comparing the CCT (Pachymetry) between torsional phaco and longitudinal phaco; the *P* value was 0.965 preoperatively and 0.415 after 3 months.

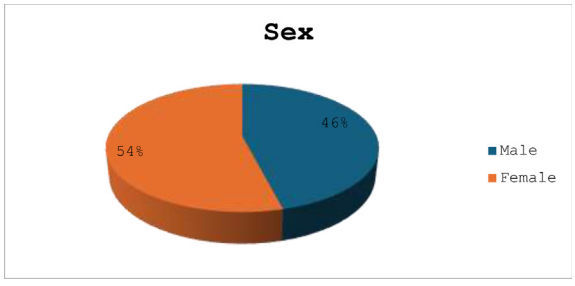

Chart 1. Ratio of males to females in our study.

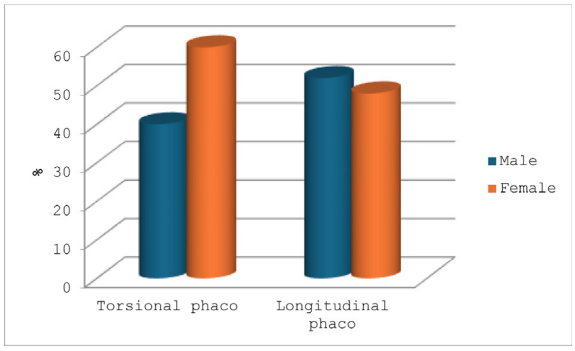

Chart 2. Sex arrangement in the two groups.

Table 3. Correlation between torsional phaco and longitudinal Phaco regarding the age.

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

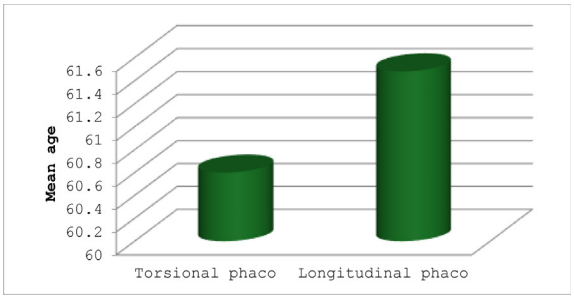

Chart 3. Mean age in torsional and longitudinal phaco.

Table 4. Comparison between torsional phaco and longitudinal phaco according to pachymetry.

Pachy	Torsional Phaco	Longitudinal Phaco	*T*-test	
	Mean ± SD	Mean ± SD	t	*P* value
Preoperative	541.800 ± 49.576	542.400 ± 47.449	−0.044	0.965
Postoperative	535.280 ± 42.886	544.480 ± 35.936	−0.822	0.415

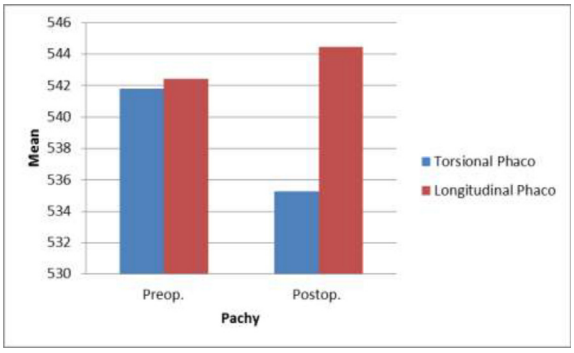

Chart 4. Correlation between torsional phaco and longitudinal phaco according to pachymetry.

4. Discussion

These days, achieving the greatest possible uncorrected vision following cataract surgery is just as important as removing the cataractous lens. This is a result of advancements in the sector. The procedure is now safer overall thanks to recent technical

advancements in surgical techniques and equipment, which motivates doctors and patients to seek surgery sooner [10].

During cataract surgery, the corneal endothelium is subjected to several insults, which, even in moderate cases, might result in temporary changes in endothelial cell function. This causes the CCT to rise. Viscoelastic, irrigation, aspiration solutions, and surgical instruments can cause direct trauma or an inflammatory process that modifies the endothelium [11].

Increased corneal thickness results from decreased endothelial pumping action to maintain corneal detumescence. By measuring corneal thickness using a pachymeter, this shift is easily quantifiable [12].

The corneal endothelium recovers gradually after damage and removes the fluid from the cornea. After some time, the cornea regains its usual thickness. Factors such as corneal endothelial cell count, inflammatory response, overall health, and surgical trauma can influence a patient's healing time [13].

Changes in endothelial function as detected by pachymetry to measure CCT are also mentioned by OT Aribaba *et al.* [14]. The mean CCT climbed to 597.9 ± 30.4 μm 24 h after cataract surgery, and then fell to 555.2 ± 24.7 μm and 525.1 ± 19.7 μm at 2–12 weeks, respectively, according to the results [14].

A different study found that there was no statistically significant change in CCT after phacoemulsification and microincision cataract surgery [15].

We compared the CCT (usually ~500 um) after surgery using torsional and longitudinal phacoemulsification in our study. We found no statistically significant difference between the two methods in terms of postoperative CCT ($P = 0.415$).

Ultimately, our study's findings demonstrated that both torsional and longitudinal phacoemulsification techniques are safe procedures with no statistically significant difference in postoperative CCT (Pachmetry). As a result, the surgeon's experience will determine which phaco category to use, torsional or longitudinal.

4.1. Conclusion

The most common 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 compared the two phacoemulsification techniques about the postoperative CCT (pachymetry) and found no statistically or clinically significant differences, suggesting that both techniques are equivalent and that each surgeon can choose their preferred phacoemulsification method. Based on surgical experience, we have observed that for longitudinal phaco, the optimal mode is the pulse mode with elevated vacuum and decreased power to reduce repulsion and heat production. On the other hand, because torsional phaco generates a lot less heat and repulsion than longitudinal phaco, the best mode for torsional phaco is the continuous mode with medium vacuum, which is sufficient to draw the material through.

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 the postoperative CCT (pachymetry). Multicenter randomized studies should be carried out to compare the two varieties of Phaco in terms of other factors including how they affect endothelial cell hexagonality.

Institutional Review Board (IRB) Approval Number

IOP00076.

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Nil.

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.

Conflict of interest

There are no conflicts of interest.

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