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ORIGINAL RESEARCH

Oblique Chop: A Novel Hook and Lock Technique for Single Step Nuclear Fracture in Cataract Surgery

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Purpose: To introduce and evaluate the efficacy of oblique chop technique designed to achieve single-pass nucleus division by leveraging both the tip and proximal arm of the chopper for simultaneous anchoring and splitting.

Patients and Methods: The oblique chop technique was performed in 60 eyes with cataracts ranging from nuclear sclerosis grades NS1 to NS3 (NS1: n=20, NS2: n=20, NS3: n=20). A side port incision was created between 90° and 100° relative to the main port to optimize the mechanical advantage for the hook-and-lock motion. During chopping, the tip of the chopper engages the central nucleus while the arm locks laterally, creating a hook-and-lock configuration that allows a single synchronized motion to fracture the nucleus without rotation or repeated attempts. The technique can be performed using a standard blunt chopper. Primary intraoperative parameters included single-attempt nuclear division rate, phacoemulsification time, cumulative dissipated energy (CDE), and capsular bag stability. Postoperative parameters included best-corrected visual acuity (BCVA), endothelial cell loss, and complication rates.

Results: Complete nuclear division was achieved in 56 of 60 eyes (93.3%) overall—19/20 eyes (95%) in NS1, 19/20 eyes (95%) in NS2, and 18/20 eyes (90%) in NS3. Mean absolute phacoemulsification time was 15.0 ± 3.7 seconds, and mean CDE was 5.0 ± 1.4. Mean endothelial cell loss at 1 month was 3.5 ± 0.8%. Mean BCVA improved from 0.78 ± 0.20 logMAR preoperatively to 0.03 ± 0.05 logMAR postoperatively ($p < 0.001$). No significant intraoperative or postoperative complications were observed.

Conclusion: Oblique Chop is a simple, reproducible, and energy-efficient nucleus division technique that utilizes the full mechanical advantage of the chopper, enabling single-pass nucleus division with reduced ultrasound energy and favorable visual outcomes in nuclear sclerosis grades 1–3. Further comparative studies are warranted to validate these findings.

Keywords: phacoemulsification, oblique chop, chopping technique, blunt chopper

Introduction

Efficient nucleus emulsification is a key determinant of safety, energy delivery, and surgical outcomes in phacoemulsification.[1]

Chopping techniques, first introduced by Kunihiro Nagahara in 1993 to reduce the need for extensive sculpting,[2] offer several advantages over traditional methods. These include lower ultrasound energy and fluid use,[3] better preservation of the corneal endothelium,[4] improved anterior chamber stability,[5] and decreased zonular stress. Over time, several key variants have emerged: horizontal chop, which engages the nuclear equator beneath the capsulorhexis;[6] vertical chop, delivering a direct downward division;[7] pre-chop, mechanically splitting the lens before phaco;[8] and quick-chop, a rapid vertical approach with minimal sculpting.[9] More recently, several modified and technology assisted approaches have been introduced. These include variations of chop techniques, crater type approaches, and femtosecond laser assisted nucleus fragmentation, reflecting the ongoing evolution of nucleus disassembly strategies.[10,11]

Despite their utility, these methods face technical challenges. In horizontal chop, passing the chopper beyond the capsulorhexis to reach the equator can be difficult in small pupils or shallow chambers, raising the risk of zonular or

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capsular injury.[6] Vertical chop requires precise depth control and firm counterforce from the phaco tip, which is often problematic in softer nuclei.[7] Pre-chop demands specialized instruments and may pose a capsular risk in dense lenses.[8] Quick-chop has a steep learning curve and may yield incomplete fractures in soft nuclei.[9] Moreover, reliance solely on the chopper tip limits mechanical control, contributing to slippage, repeated engagements, longer surgery, higher cumulative dissipated energy (CDE), and increased capsular stress—factors strongly linked to corneal endothelial cell loss and reduced safety during surgery.[12,13]

Conventional chopping techniques rely on tip-dependent mechanics, applying force at a single point, which reduces stability and often necessitates repeated manoeuvres. While sharp choppers aid penetration but may increase capsular stress, blunt choppers distribute forces more broadly and offer better control. However, the proximal arm remains underutilized, limiting mechanical efficiency.

The purpose of this study was to introduce and evaluate the Oblique Chop technique, a modified chopping manoeuvre designed to achieve stable single-step nuclear division by utilizing both the tip and proximal arm of a blunt chopper in a hook and lock configuration. The primary endpoint of this study was the rate of successful single-step complete nuclear division. Secondary endpoints included phacoemulsification time, cumulative dissipated energy (CDE), postoperative best-corrected visual acuity, endothelial cell loss, and intraoperative or postoperative complications. This prospective study aimed to assess the feasibility, safety, and reproducibility of the technique across varying grades of nuclear sclerosis.

Patients and Methods

Study Design and Patient Selection

This prospective, single-surgeon study included 60 eyes of 60 patients with senile cataracts who underwent surgery at a tertiary eye care center between November 2025 and January 2026. All surgeries were performed by a single experienced cataract surgeon (TOP) with 8 years of surgical experience and more than 15,000 phacoemulsification procedures. Inclusion criteria were eyes with visually significant cataracts graded NS1 to NS3 according to the Lens Opacities Classification System III (LOCS III).[14] Patients with pseudoexfoliation, traumatic cataracts, zonular dialysis, or a history of prior intraocular surgery were excluded from the study.

Surgical Technique: Oblique Chop

This study was approved by the Ethics Committee of Dr. Om Parkash Eye Institute. DOPEI/EC/ASR/14-2025 (dated 07 November 2025). This trial was registered in the Clinical Trials Registry of India (CTRI/2025/11/097732). All participants provided written informed consent before participating in the study. The study was conducted in accordance with the Declaration of Helsinki.

All surgeries were performed under topical anesthesia using the Centurion Vision System (Alcon Laboratories, Fort Worth, TX, USA) by a single surgeon (TOP). A 2.8 mm clear corneal main incision was made, along with a narrow calibrated side port incision placed more than 90–100° relative to the main port to optimize the mechanical advantage for the oblique-Chop maneuver. Following capsulorhexis and hydrodissection, the central anterior epinucleus was aspirated with the phaco tip. This step enabled the surgeon to better assess the grade of the endonucleus.

In cases of NS1 cataracts, the nuclear core was engaged with minimal phaco power rather than deep embedding to prevent misholding or aspiration of the nucleus. The goal was stabilization of the nucleus to provide adequate counter-traction for the subsequent chop. In NS2–NS3 grades, the phaco tip was embedded centrally into the nucleus using standard phaco parameters to provide firm purchase before initiating the chop (Video S1).

A blunt chopper (Phaco Chop Blunt; 1.25 mm tip length, 1 mm chopping edge, 0.25 mm bulbous tip; overall length 127 mm; G4-138; Indo-german) was used in all cases. The phaco tip was embedded centrally into the nucleus, while the chopper tip was inserted to a depth of approximately two-thirds of the nuclear thickness. The chopping maneuver was executed as a slow, controlled circular motion in a diagonal orientation with both the tip and the proximal portion of the chopper aligned diagonally within the nucleus. This configuration enhanced purchase and facilitated a stable, complete fracture along the central plane in a single step (Figures 1–4).

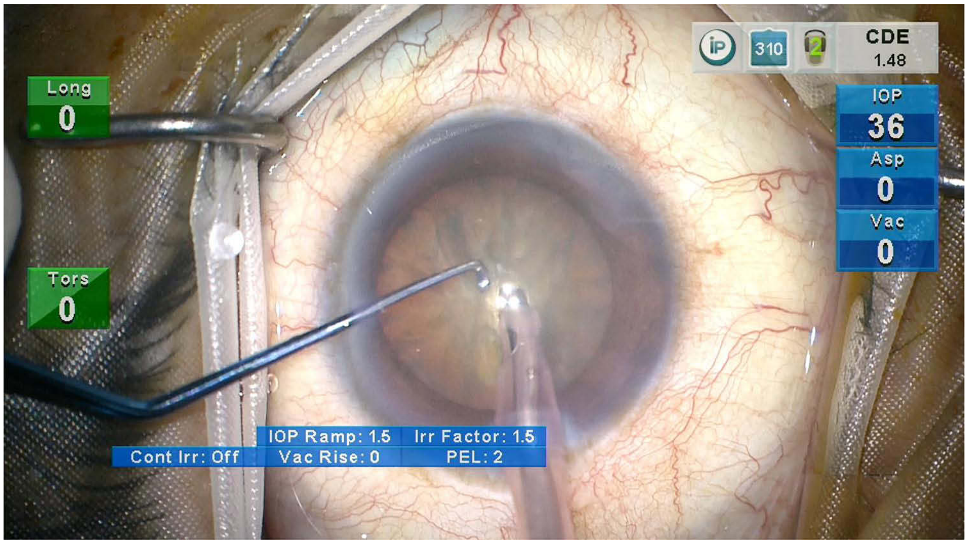

Figure 1 Oblique orientation of chopper.

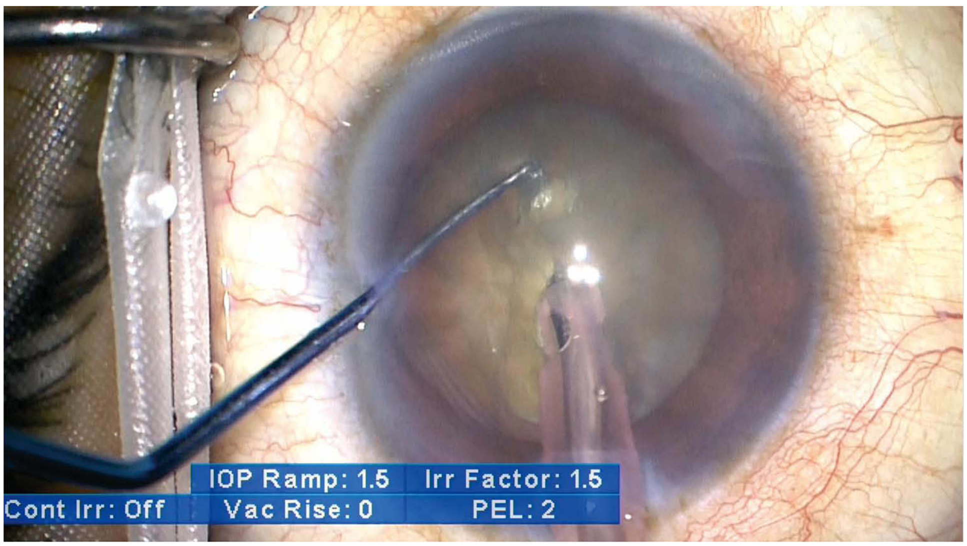

Figure 2 Tip and the proximal portion of the chopper aligned diagonally within the nucleus.

After the initial nuclear fracture, the nucleus was further divided into four quadrants using the same hook-and-lock maneuver, with no additional repositioning. Each quadrant was then emulsified with standard phacoemulsification parameters.

Cortical material was removed with coaxial irrigation/aspiration, and a posterior chamber intraocular lens (IOL) was implanted in the bag. Incisions were sealed with stromal hydration.

Postoperative Care and Follow-Up

Patients were examined on day 1, day 3, day 14, and at 1 month postoperatively. The postoperative regimen included:

- Moxifloxacin-dexamethasone drops four times daily, tapered over 4 weeks.
- Nepafenac 0.1% drops twice daily for 1 month.
- Sodium hyaluronate 0.1% lubricating drops four times daily for 1 month.

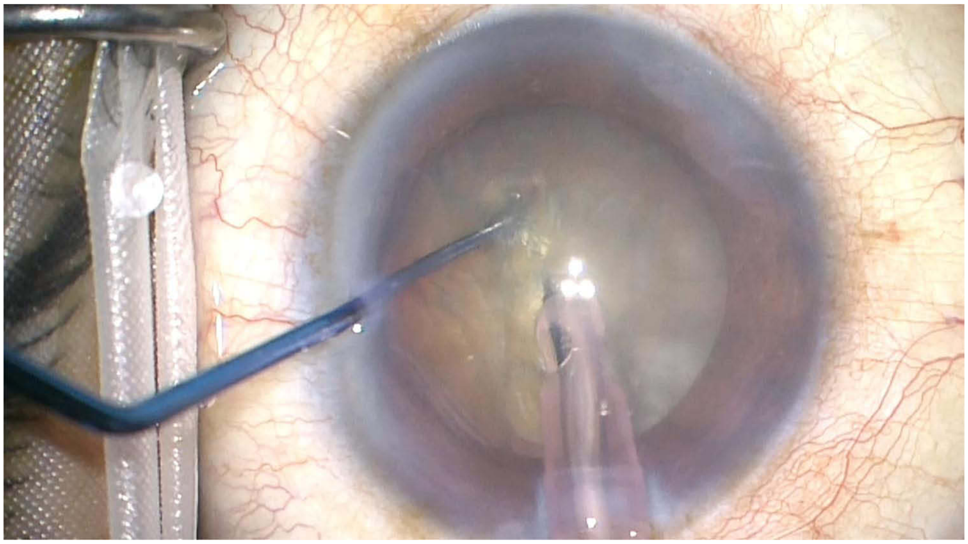

Figure 3 Slow, controlled circular motion of the tip and proximal portion of the chopper in a diagonal orientation was inserted to a depth of approximately two-thirds of the nuclear thickness.

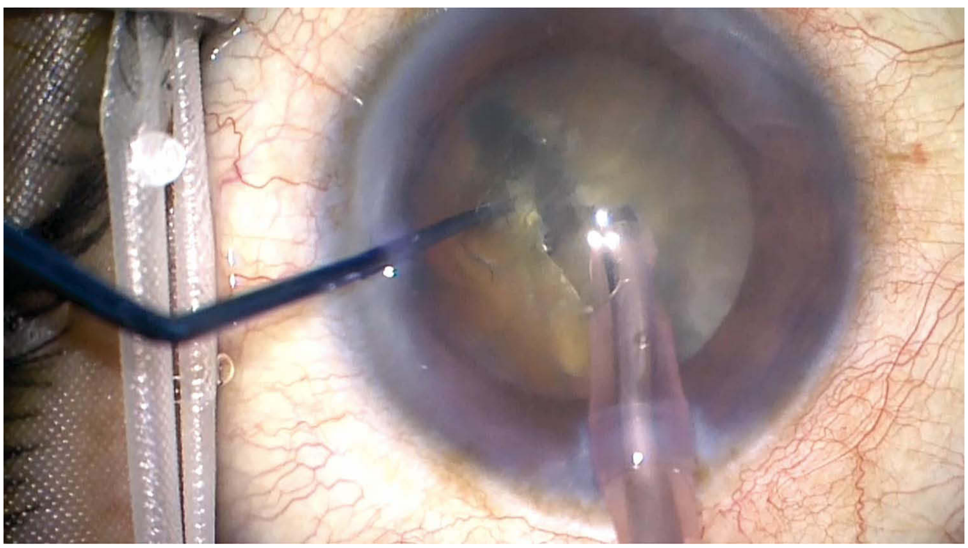

Figure 4 Hook and Lock configuration facilitated a stable, complete fracture along the central plane in a single step.

Statistical Analysis

This study was designed as a prospective, interventional, longitudinal study, ensuring systematic data collection and temporal assessment of outcomes. The study included consecutive eligible patients during the defined study period, reflecting real-world clinical practice. While the sample size was modest, it was sufficient to demonstrate consistent outcomes across all groups. A total of 60 eyes were included in this technique across different grades of nuclear sclerosis.

Data entry and analysis were conducted using Microsoft Excel Version 16. Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequency (f) and percentage (%).

Comparisons of continuous variables across nuclear sclerosis grades (NS1, NS2, and NS3) were performed using one-way analysis of variance (ANOVA). Categorical variables were analyzed descriptively using proportions. A p-value of < 0.05 was considered statistically significant.

Results

A total of 60 eyes were included in the study, which were divided evenly into three groups based on the level of nuclear sclerosis (NS1, NS2, and NS3) with 20 eyes in each group. Overall, there was a high percentage of one-step total successful nuclear section completion across the groups (93.3%). Additionally, the success rates for each grading were also quite comparable across all groups (NS1 95%, NS2 95%, NS3 90%).

There was a statistically significant increase in absolute phacoemulsification time with increasing nuclear sclerosis grade (NS1: 11.8 ± 2.0 sec, NS2: 15.0 ± 2.8 sec, NS3: 18.2 ± 3.22 sec; $p < 0.001$). A corresponding increase was observed in cumulative dissipated energy (CDE) (NS1: 3.6 ± 0.7, NS2: 4.9 ± 1.0, NS3: 6.4 ± 1.32; $p < 0.001$), indicating higher energy requirements for denser nuclei. Post hoc analysis displayed significantly longer phaco time as the grade increased (NS1 vs NS2 = $p < 0.01$; NS2 vs NS3 = $p < 0.01$). The mean difference in phaco time was 6.4 seconds (95% CI: 4.3–8.5) between NS1 and NS3.

There was also a statistically significant difference in preoperative best-corrected visual acuity (BCVA) among all the groups, and BCVA worsened with higher nuclear grades due to the presence of denser nuclei ($p < 0.001$). However, the mean BCVA at the end of 1 month after surgery was similar among the groups ($p = 0.08$), indicating that the level of success in visual outcomes can be equitably achieved regardless of the original severity of each grade.

The analysis within each group showed a statistically significant improvement in the mean BCVA for each group ($p < 0.001$), therefore providing excellent postoperative visual recovery for all eyes.

The mean endothelial cell loss at 1 month was 3.5 ± 0.8%. There was a statistically significant increase in percent loss with increasing nuclear grade (NS1: 3.1 ± 0.7%, NS2: 3.4 ± 0.8%, NS3: 3.9 ± 0.9%; $p = 0.03$). However, the absolute differences between groups were clinically small. Corneal endothelial cell density was measured using a Nidek CEM-530 specular microscope.

No intraoperative or postoperative complications were observed in any group.

Oblique chop study outcomes are summarized in Table 1.

Table 1 Oblique Chop Study Outcomes (n = 60 Eyes)

Parameter	NS1 (n=20)	NS2 (n=20)	NS3 (n=20)	Overall (n=60)	p-value*
Single-step complete nuclear division (n, %)	19 (95%)	19 (95%)	18 (90%)	56 (93.3%)	-
Phacoemulsification time (seconds, mean ± SD)	11.8 ± 2.0	15.0 ± 2.8	18.2 ± 3.2	15.0 ± 3.7	<0.001
Cumulative Dissipated Energy (CDE) (mean ± SD)	3.6 ± 0.7	4.9 ± 1.0	6.4 ± 1.3	5.0 ± 1.4	<0.001
BCVA Pre-op (logMAR, mean ± SD)	0.64 ± 0.15	0.78 ± 0.18	0.92 ± 0.20	0.78 ± 0.20	<0.001
BCVA Post-op (1 month) (logMAR, mean ± SD)	0.02 ± 0.05	0.03 ± 0.05	0.05 ± 0.06	0.03 ± 0.05	0.08
p-value (BCVA change)	<0.001	<0.001	<0.001	<0.001	-
Endothelial cell loss % (1 month) (mean ± SD)	3.1 ± 0.7	3.4 ± 0.8	3.9 ± 0.9	3.5 ± 0.8	0.03
Intraoperative complications (n)	0	0	0	0	-
Postoperative complications (n)	0	0	0	0	-

Note: *p-values calculated using one-way ANOVA.A p-value < 0.05 was considered statistically significant.

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Discussion

Several nucleus disassembly techniques have been established in modern phacoemulsification, including divide-and-conquer, stop-and-chop, vertical chop, horizontal chop, pre-chop, and quick-chop. Each has proven effective across different cataract grades and remains widely practiced.[1–5] Vertical chop is often favoured for dense nuclei, while horizontal chop can be advantageous in medium-density cases with favourable cortical cleaving planes. Pre-chop offers energy efficiency by fragmenting the nucleus before phacoemulsification, and quick-chop accelerates vertical disassembly with minimal sculpting.[6–9]

Despite their success, these techniques present notable limitations. Vertical chop demands precise depth control and strong countertraction, and typically requires the use of a sharply pointed chopper tip to achieve adequate nuclear penetration.[4] This makes the technique less effective in softer nuclei and may increase the risk of capsular stress if the tip inadvertently advances too deep. Horizontal chop requires advancing the chopper beneath the rhexis toward the equator, which can be technically challenging, especially in small pupils, shallow anterior chambers, or cases with zonular weakness.[3–5] Pre-chop requires specialized instruments and may impose capsular stress in brunescent cataracts.[8] Quick-chop, while efficient, has a steep learning curve and can yield incomplete fractures in soft lenses.[9] Furthermore, many conventional methods rely primarily on the chopper tip alone, restricting mechanical control and often necessitating repeated maneuvers, which increase cumulative dissipated energy (CDE), ultrasound time, and intraocular stress.[12,13]

To address these limitations, several modifications have been described, including altered chop variations, femtosecond laser-assisted nucleus fragmentation, and the use of specialized choppers.[6–8] Although these approaches may improve precision or efficiency, their widespread adoption is limited by cost, equipment availability, a steep learning curve, and variable reproducibility.

The oblique chop differs fundamentally from both vertical and horizontal chop techniques. It does not involve the horizontal sweeping motion of the chopper beneath the nucleus seen in horizontal chop nor the vertical impaling or downward thrust characteristic of vertical chop. Instead, the chopper moves diagonally in a controlled arc, creating a unique force vector that allows simultaneous anchoring and splitting of the nucleus with minimal stress on the capsule and zonules.

In this study, we describe a nuclear fracture technique that employs the phaco tip together with both the tip and the proximal arm of a blunt chopper, oriented diagonally, to accomplish a stable, single-step chop.

Our oblique chop technique employs a simple mechanical modification of the chopper's function. Unlike conventional approaches that rely only on the chopper tip, Oblique-Chop simultaneously engages both the tip and the proximal portion of the chopper arm in a diagonal orientation. By combining these two contact points, a stable hook-and-lock configuration is achieved. The manoeuvre is executed with a slow, controlled diagonal circular motion after embedding the phaco tip centrally, ensuring reliable propagation of the fracture plane through the nucleus. The technique leverages a combined wedge-and-shear force system, in which the chopper tip acts as a penetrating wedge while the proximal arm provides a stabilizing shear force. This dual-force mechanism enhances the effectiveness of nuclear fracture by expanding the area of engagement and distributing stress more evenly across the lens. In contrast, traditional techniques rely on point loading of the chopper tip, which can lead to slippage, incomplete fractures, or repeated attempts. By offering broader anchorage and a more controlled fracture plane, Oblique chop may reduce intra-operative variability and provide a more controlled fracture pattern.

In this study, the technique was successfully applied across NS1-NS3 cataracts. In moderate-density lenses the phaco tip provides firm purchase under routine parameters, facilitating effective chopping. In soft nuclei, minimal phaco power stabilizes the core without aspiration or mis holding to facilitate chopping. The technique achieves nuclear division in a single, controlled step, eliminating the need for repeated manoeuvres, thereby minimizing mechanical stress on intraocular structures.

A key determinant of the success of the Oblique chopping is the placement of the side port incision, which should be fashioned more than 90–100 degrees from the main incision, adjusted according to the surgeon's comfort. If created at a smaller angle to the main incision, the maneuverability is restricted and the diagonal rotational movement of the chopper becomes difficult. Our technique allows chopper entry into the paracentral or mid-peripheral nucleus, central to the capsulorhexis margin, thereby avoiding edge damage while eliminating the hazardous counterforces associated with vertical chop. The hook-and-lock configuration provides stable nuclear engagement without tilt and without incomplete chopping.

The biomechanical principles of the oblique chop technique may offer potential advantages in several complex surgical scenarios, warranting further evaluation. In zonulopathy, distribution of compressive forces over a larger surface area in a single attempt may reduce stress on the capsular bag. As oblique chop avoids peripheral nuclear manoeuvring, its potential advantage in small pupils remains to be evaluated. In posterior polar cataracts, it may enable nuclear segmentation with reduced vertical capsular stress. In eyes with compromised visualization, such as corneal opacities, the technique may permit effective nuclear fracture without deep chopper penetration. In harder cataracts, the technique may be applicable; however, a sharp chopper is preferable and should be used by experienced surgeons to minimize the risk of capsular complications.

Although no intraoperative complications were encountered in this series, potential challenges associated with the technique may include incomplete nuclear fracture, chopper slippage, and difficulties during the early learning curve. Careful positioning of the chopper and controlled movements are important to maintain capsular stability and ensure effective nuclear segmentation.

In summary, the oblique chop technique demonstrated controlled nuclear segmentation across nuclear sclerosis grades 1–3, transforming the role of the chopper from a single-point instrument to a dual-point lever. By combining wedge and shear forces in a diagonal hook-and-lock configuration, it enables efficient, low-energy, and safe nuclear fracture. This prospective proof of concept study was designed to introduce the technique and evaluate its feasibility and reproducibility.

Limitation

This study has certain limitations. As a single-surgeon series, the findings may have limited generalisability. The absence of a control group using established chopping techniques further restricts comparative interpretation. In addition, the technique relies on adequate nuclear purchase and may not be suitable for ultra-soft cataracts where stable engagement is difficult. Further comparative studies are warranted to better define the indications and limitations of this technique.

Conclusion

Oblique chop enables controlled single-step nuclear segmentation using a diagonal hook-and-lock configuration with a blunt chopper that engages both the tip and proximal arm. In this series, favourable intraoperative parameters and low corneal endothelial cell loss were observed; however, complication rates are multifactorial and not solely technique dependent. Further comparative studies are required to define its clinical role.

Data Sharing Statement

The authors intend to share individual deidentified participant-level data upon reasonable request.

Deidentified participant-level data, including intraoperative parameters (phacoemulsification time and cumulative dissipated energy) and postoperative outcomes (best-corrected visual acuity, endothelial cell loss, and complication rates), will be made available. The study protocol will be made available upon reasonable request. Data can be accessed by contacting the corresponding author via Email at tushya@aol.in, subject to institutional policies and ethical considerations.

Author Contributions

Tushya Om Parkash contributed to the development of the Oblique Chop technique, surgical execution, data acquisition, and manuscript drafting and review. Rohit Om Parkash contributed to the study conception and design, data analysis and interpretation, and critical revision of the manuscript. Sehar Om Parkash contributed to manuscript writing, literature review, data review, and editing. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in

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drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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