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ORIGINAL ARTICLE

Phacoemulsification in Cases of Zonular Weakness Using in Situ Nuclear Disassembly Without Nuclear Rotation

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Abstract

Background: **Due to zonular dehiscence or weakness, cataract surgery may result in late intraocular lens subluxation or dislocation, vitreous loss, dropped nuclei fragments, or all of these complications.**

Aim: **The objective of this study is to evaluate the occurrence and intensity of intraoperative problems in pseudoexfoliation (PEX) cases when employing in situ nuclear disassembly without nuclear rotation.**

Patients and methods: **On 100 eyes of 100 cases with zonular weakness, this prospective, interventional, comparative study was carried out. Fifty patients undergoing phacoemulsification with in situ nuclear disassembly and the other 50 patients undergoing conventional chopping technique were admitted to the Ophthalmology Department, Faculty of Medicine, Al-Azhar University and carried out in Al-Hussein University Hospital.**

Results: **There were not any statistically significant differences in age or sex observed between the two groups. Regarding type of weakness, 50 cases were PXE and 50 cases were senile weakness over 70 years. Time of surgery was 15.02 ± 2.83 min in cases undergoing in situ nuclear disassembly and 19.9 ± 2.75 min in cases undergoing the conventional method, indicating a large and significant difference between the two groups.**

Conclusion: **The utilization of the Kelman-type phaco tip allows for the execution of lateral sweep sculpting and in situ cracking techniques in cases where there is a presence of weak zonules and zonular weakness. This facilitates the safe and efficient performance of phacoemulsification procedures without the need for nuclear rotation.**

Keywords: Nucleus disassembly, Phacoemulsification, Zonular weakness

1. Introduction

During the surgical procedure for cataract removal, the occurrence of zonular dehiscence or weakening can result in several complications, such as vitreous loss, fallen nuclei or lens fragments, and delayed postoperative subluxation or displacement of the intraocular lens. When the zonules are weak due to trauma, senility after 70, pseudo exfoliation syndrome (PEX), or Marfan syndrome, nuclear manipulations can stress them.[1]

To better distribute forces on the zonules, the surgeon may use capsular tension rings (CTRs) after the nucleus has been removed. In eyes with capsule-zonular disorders, hydro dissection of the cortical cleavage may speed up the process. On the other hand, with PEX, this is not always required.[2]

Various techniques have been employed to elucidate the process of in situ nuclear disintegration. By employing one of these techniques, it is possible to safely reduce the size of the nucleus by two-thirds without any manipulation or rotation, through the removal of a deep, central, equilateral triangular wedge. The outer rim of the surviving nucleus is divided into three segments. The utilization of brief pulses of phaco power has been demonstrated to be a secure method for performing endocapsular

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phacoemulsification, wherein each segment is delicately gripped and afterward drawn into the core cavity.[2]

The in-situ nuclear disassembly technique employs a simplified sculpting and cracking approach, along with phacoemulsification and a Kelman-style tip. The aforementioned approach does not necessitate the rotation of the capsular bag nucleus or the utilization of hydrodissection. The utilization of the Kelman-style curved phacoemulsification needle becomes advantageous in facilitating the processes of carving and cracking.[3]

The primary advantage of in situ nuclear disassembly is its ability to reduce intracapsular lens manipulation, particularly the rotation of the nucleus. Additionally, in certain instances, this technique completely removes the need for hydrodissection, thereby reducing stress on the capsule and zonules. In addition, it is worth noting that the process of in situ nuclear deconstruction does not require any specialized equipment.[3]

Mahdy[4] assessed the frequency and seriousness of intraoperative complications associated with phacoemulsification in cases of PEX. The researchers arrived at the conclusion that the Kelman style phaco tip's flexibility might be utilized for performing lateral sweep sculpting and in situ cracking approaches in cases of PEX when there is a concern regarding weakened zonules, with the aim of achieving a safe and successful phacoemulsification procedure without nuclear rotation. The avoidance of zonular stress occurs by the maintenance of a stable position for the nucleus, wherein it is not subjected to any shifting or rotational movements under specific circumstances.

The objective of this study is to evaluate the occurrence and intensity of intraoperative problems in PEX cases when employing in situ nuclear disassembly without nuclear rotation.

2. Patients and methods

This prospective, interventional, comparative study was conducted on 100 eyes of 100 cases of cataracts with weak zonules (pseudoexfoliation and old age), 50 cases underwent phacoemulsification with in situ nuclear disassembly and the other 50 cases underwent conventional method (Stop and Chop technique). Those patients were admitted to Al-Hussein University Hospital. The ethical approval was obtained by the Faculty of Medicine Council in October 2019 and Al-Azhar University Council in November 2019.

Exclusion criteria: Trabeculectomy, vitrectomy, retinal reattachment surgery, or eye trauma history.

2.1. Methods

After thoroughly explaining the procedure and its potential outcomes, we obtained each patient's written informed consent. These patients underwent phacoemulsification with in situ nuclear disassembly, and both the postoperative visual outcome and intraoperative complications were noted.

2.2. Anesthesia

In all patients, a 50/50 mixture of 2% lidocaine and 0.5% bupivacaine was used as local peribulbar anesthesia.

2.3. Surgical procedure

A 2.2 mm Clear Cut blade was used to make a transparent corneal incision (temporal or superotemporal). Using a Micro-Smooth ULTRA Infusion Sleeve and a Kelman-style curved 45° phacoemulsification tip, an 80–90% deep central vertical groove can be made along the entire length of the nucleus.

A side port manipulator should be placed at the base of the left wall when performing phacoemulsification, and the phacoemulsification tip should be placed at the base of the right wall.

The lateral groove of the right heminucleus is subsequently employed for the insertion of the Kelman-style tip and side port manipulator. Each of the left and right heminuclei contains two different quadrants.

The phacoemulsification tip effectively captures all four quadrants, bringing them towards the central region of the pupil, and then fragmenting them through the use of a chopper against the phacoemulsification tip, utilizing the conventional machine settings designed for the extraction of torsional quadrants.

The topical administration of prednisolone acetate eyedrops at a concentration of 1% was initiated for the initial 1 week hourly administration, followed by administration every three hours for an additional 1 week, and decreased to every 6 h administration for a duration of 10 days.

Topical adminstration of broad spectrum antibiotics (moxifloxacin) with the same protocol of prednisolone acetate.

2.4. Statistical evaluation

The utilization of SPSS (Statistical Package for the Social Sciences) version 15 for Windows (SPSS Inc, Chicago, IL, USA) was employed in order to input codes, manipulate data, and conduct analyses on the resulting outcomes. The qualitative data was presented using numerical values and percentages. The χ^2 test was utilized to conduct a comparison

between the groups. The researchers employed the Kolmogorov-Smirnov test to assess the normality of the quantitative data. The data exhibited a normal distribution and were presented in the form of mean plus or minus standard deviation. The student *t*-test was utilized to conduct a comparison between the two groups. The definition of statistical significance was established as a probability value below 0.05.

3. Results

This study included a total of 100 eyes from 100 individuals who underwent cataract surgery due to weak zonules, namely PEX and old age. Among these instances, fifty individuals underwent phacoemulsification with in situ nuclear disassembly. Out of the 50 patients, 20 (40%) were males and 30 (60%) were females, with a mean age of 67.04 ± 11.91 years. The remaining 50 cases were subjected to the traditional stop-and-chop approach. Among these cases, 25 (50%) were male and 25 (50%) were female, with a mean age of 70.7 ± 8.56 years. There was no statistically significant difference observed between the male and female groups.

There were no cases of postoperative instability of refraction in either of the two study groups, and there was no discernible difference between them ($P > 0.05$).

Regarding type of weakness, PXE was found in 30 (60%) cases undergoing in situ nuclear disassembly and 20 (40%) cases undergoing the conventional method. In the in situ method, 20 (40%) patients were found to be older than 70 years, and in conventional method, 30 (60%) patients were found to be older than 70 years old. Regarding the particular type of weakness, there was a statistically significant difference between the two groups under study ($P < 0.05$), Table 1.

Time of surgery was 15.02 ± 2.83 min in cases undergoing in situ nuclear disassembly and 19.9 ± 2.75 min in cases undergoing conventional method. The results demonstrate a statistically significant distinction between the two groups ($P < 0.001$), Table 2.

No significant distinction was observed between the two groups with regard to the occurrence of posterior capsule rupture, extended rhexis, anterior vitreous prolapse, or zonular dialysis ($P > 0.05$), Table 3.

In the in situ approach, it was observed that 10 (20%) cases had a logMAR visual acuity (VA) of 1.0, whereas 15 (30%) patients had a VA of 0.9, and 25 (50%) cases had a VA of 0.8, as shown by the LogMAR notation. In the conventional approach, it was observed that 9 (18%) patients exhibited a logMAR (VA) of 1.0, 14 (28%) patients had a VA of 0.9, and 27 (54%) patients had a VA of 0.8 using LogMAR notation. There was no statistically significant difference observed between the two groups under study with respect to postoperative best-corrected visual acuity (BCVA) measured in the logarithm of the (LogMAR) units, as shown by a *P* value greater than 0.05, Table 4.

Table 2. Comparison between in situ and conventional methods regarding time of surgery.

	In situ method ($n = 50$)	Conventional method ($n = 50$)	*P*
Time of surgery	15.02 ± 2.83	19.9 ± 2.75	<0.001 (HS)

Table 3. Comparison between in situ and conventional methods regarding complications.

	In situ method ($N = 50$) [n (%)]	Conventional method ($N = 50$) [n (%)]	*P*
Rupture posterior capsule	1 (2)	3 (6)	0.307
Extended rhexis	0	0	–
Anterior vitreous prolapse	0	1 (2)	0.315
Zonular dialysis	2 (4)	3 (6)	0.646

Table 4. The visual outcome in the postoperative period, as measured by the logarithm of the minimum angle of resolution (logMAR) notation, and the number of cases having ocular comorbidity prior to surgery were assessed.

Postop best-corrected visual acuity LogMAR chart	In situ method ($N = 50$) [n (%)]	Conventional method ($N = 50$) [n (%)]	*P*
0.8	25 (50)	27 (54)	0.921
0.9	15 (30)	14 (28)	
1.0	10 (20)	9 (18)	
Mean ± SD	0.87 ± 0.08	0.86 ± 0.08	0.702

Table 1. Comparison between in situ and conventional methods regarding type of weakness.

Type of weakness	In situ method ($N = 50$) [n (%)]	Conventional method ($N = 50$) [n (%)]	*P*
PXE	30 (60)	20 (40)	0.046 (S)
Old age >70 y	20 (40)	30 (60)	

4. Discussion

The phacoemulsification technique, with a Kelman-style tip, is employed to achieve in situ nuclear breakdown by means of sculpting and cracking. The technique does not necessitate the use of hydraulic dissection or the rotation/mobilization of the nucleus within the capsular bag. The technique involves utilizing the sculpting and cracking functionalities of a curved phacoemulsification needle equipped with a Kelman-style tip, Koplin *et al*.[3]

The present study aimed to evaluate the safety and incidence of intraoperative problems associated with phacoemulsification using in situ nuclear disassembly technique without nuclear rotation.

This study was to assess 100 cases of cataract with zonular weakness that underwent phacoemulsification with in situ nuclear disassembly at the Department of Ophthalmology, Faculty of Medicine, Al-Azhar University. The study design was prospective, interventional, and comparative in nature.

The patients underwent a surgical procedure known as phacoemulsification, which involved the fragmentation and removal of the lens nucleus within the eye. While this approach is similar to that used by Koplin *et al*.[3]

The current method avoids the drawbacks of nucleus rotation while utilizing the benefits of the divide and conquer strategy. The postoperative visual outcome was also assessed, and intraoperative complications were noted.

In the present study, the average age of participants was determined to be 67.04 ± 11.91 years in the in situ method group and 70.7 ± 8.56 years in the traditional method group. However, statistical analysis revealed that there was no significant difference between the two groups ($P > 0.05$). Out of the total sample size of 50 instances that underwent phacoemulsification with in situ nuclear disassembly, 20 individuals were identified as male, accounting for 40% of the sample, while the other 30 individuals were identified as female, constituting 60% of the sample. Out of the total 50 instances subjected to the conventional approach, an equal number of 25 (50%) cases were identified as males and 25 (50%) cases were identified as girls. Upon doing a comparative analysis between the two groups, it was seen that there were no statistically significant differences in terms of gender ($P > 0.05$).

Mahdy[4] a study was conducted wherein an in situ nuclear disassembly approach was employed in 103 instances of PEX in order to evaluate the occurrence and safety of intraoperative problems during phacoemulsification. Among the total of 103 cases, a majority of 55 (53.4%) cases were identified as male, while the remaining 48 (46.6%) cases were classified as female. The average age was found to be 60.53, with a standard deviation of 9.73.

Using Ozil IP (Alcon Laboratories, Inc, Fort Worth, TX), Soliman Mahdy *et al*.[5] evaluated the association between postoperative endothelial cell loss and microcoaxial phaco parameters in routine cataract surgery. Age-related cataract was the cause of blindness in 120 people, with a mean (SD) age of 59.68 years old (9.47). The percentage of males in the group was 47.5% (57/120), while the percentage of females was 52.5% (63/120).

The present study aimed to evaluate the occurrence and intensity of intraoperative problems in PEX cases when employing in situ nuclear disassembly without nuclear rotation. Age-related cataract was the cause of blindness in 120 people, with a mean (SD) age of 59.68 years old (9.47). The percentage of males in the group was 47.5% (57/120), while the percentage of females was 52.5% (63/120).

Regarding type of weakness, PEX was found in 30 (60%) cases undergoing in situ nuclear disassembly and 20 (40%) cases undergoing conventional method. In the in situ method, 20 (40%) patients were found to be older than 70 years and in conventional method, 30 (60%) patients were found to be older than 70 years old. Statistically, the two groups differed significantly in the kinds of weaknesses they experienced ($P < 0.05$).

In our research, time of surgery was 15.02 ± 2.83 min in cases undergoing in situ nuclear disassembly and 19.9 ± 2.75 min in cases undergoing conventional method. The data reveals a statistically significant disparity of great magnitude between the two groups. The statistical significance level, denoted as P less than 0.001, indicates that the observed result is highly unlikely to have occurred by chance alone.

Intraoperative complications such as posterior capsule rupture, extended rhexis, anterior vitreous prolapse, and zonular dialysis. There was not no statistically significant difference observed compared both groups in our study ($P > 0.05$).

Hyams *et al*.[6] reported that patients with PEX had a 5.8% rate of intraoperative complications, while patients without PEX had a 4.0% rate.

In another study conducted by Shingleton *et al*.,[7] according to the findings, it was observed that 2.0% of individuals in the nonhigh risk population and 19.6% of individuals in the high risk group with zonular affection required a vitrectomy.

Mahdy discovered that 5 cases had intraoperative complications. One instance involved the occurrence of posterior capsular rupture, while four

instances involved the occurrence of partial zonular dehiscence, with three cases exhibiting an angle of less than 90° and one case exhibiting an angle greater than 180°, but these conditions were not generally serious.

In our study, in in situ method, 10 (20%) patients had logMAR VA 1.0, 15 (30%) cases had VA 0.9, and 25 (50%) patients had VA 0.8 LogMAR notation. In conventional method, nine (18%) people had logMAR (VA) 1.0, 14 cases (28%) had VA 0.9, and 27 (54%) cases had VA 0.8 LogMAR notation. There was no significant difference between two studied groups regarding postoperative BCVA LogMAR notation ($P > 0.05$).

According to Mahdy's research, out of the total number of cases, 37 instances, accounting for 35.9%, exhibited Best Corrected Visual Acuity (BCVA) values of 0.48 or below. Conversely, 66 patients, constituting 65.1%, demonstrated BCVA values of 0.3 or higher, as denoted by the logarithmic Minimum Angle of Resolution (logMAR) notation.

In studies of Koplin *et al*.,[3] no information was available regarding the visual result. In the study by Woodlief and Woodlief,[2] there were different levels of lens hardness, but the proportion of each nuclear hardness was not mentioned in the study. Additionally, preoperative comorbidity factors, particularly the status of the cornea, were not mentioned, and all of these factors affected the visual outcome in the current study.

In the study by Koplin *et al*.,[3] no information about the patients' characteristics, preoperative comorbidity, visual outcome, or intraoperative complications was available. The same applies to the article presented by Kim.[8]

In instances of PEX, characterized by preexisting fragility of the zonules and susceptibility to zonular dehiscence and dialysis, the mitigation of nuclear rotation serves to prevent further trauma and zonular stress, hence contributing to enhanced patient safety.

The Infinity machine offers several advantages, including a small incision and a stable anterior chamber that minimizes wound leakage. Additionally, its integration of effective torsional phacoemulsification technology enhances safety by reducing repulsion and maintaining the proximity of nuclear pieces to the phacoemulsification tip, specifically in the central region of the pupil.

In instances of PEX with a potential issue of zonular weakness, it has been determined that the Kelman style phaco tip's adaptability allows for the utilization of lateral sweep sculpting and in situ cracking procedures. These techniques can be employed to successfully and safely accomplish phacoemulsification without the need for nuclear rotation. In order to mitigate zonular stress, it is imperative to refrain from any movement or rotation of the nucleus under specific circumstances.

The limitations of our study include the relatively small sample size and that the follow-up was only 6 months.

5. Conclusion

In instances of PEX with a potential issue of zonular weakness, the present approach involves utilizing the flexibility of the Kelman type phaco tip to execute lateral sweep sculpting and in situ cracking techniques. This method ensures a secure and efficient phacoemulsification procedure without the need for nuclear rotation. The mitigation of zonular stress can be achieved through the implementation of measures that prevent the nucleus from undergoing movement or rotation under the given circumstances.

Conflicts of interest

No conflict of interest: yes.

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