

Under-Iris Capsulorhexis in Poorly Dilated Pupils During Phacoemulsification: A Case Series Study

Mohamed Ahmed Siddig*

Faculty of Medicine, Omdurman Islamic University, Sudan

***Corresponding Author:** Mohamed Ahmed Siddig, Faculty of Medicine, Omdurman Islamic University, Sudan.

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Abstract

Phacoemulsification cataract surgery requires adequate pupillary dilation to ensure safe and effective performance, particularly during the creation of a continuous curvilinear capsulorhexis (CCC). However, in certain clinical situations, sufficient dilation may be difficult to achieve or deliberately avoided, such as in patients with Intraoperative Floppy Iris Syndrome (IFIS) [1], advanced diabetes, or narrow-angle glaucoma [5]. This study evaluates a novel technique termed under-iris capsulorhexis, in which the capsulorhexis is created beneath the iris plane in eyes with small or non-dilating pupils [2,4]. The iris serves as a structural support, while the contrast between the stained and unstained anterior capsule provides a reliable visual guide. A total of 850 eyes underwent cataract surgery using this technique, demonstrating high safety and efficacy without major intraoperative or postoperative complications. The technique also showed particular benefit in patients with narrow-angle glaucoma [5], offering a practical alternative in settings lacking mechanical pupil expansion devices [4].

Keywords: Cataract Surgery; Phacoemulsification; Small Pupil; Under-Iris Capsulorhexis; IFIS; Narrow-Angle Glaucoma

Introduction

Adequate pupillary dilation is fundamental for phacoemulsification, as it facilitates optimal visualization and precise execution of capsulorhexis. Several clinical conditions, however, may limit pupil dilation, including chronic use of alpha-adrenergic antagonists (associated with IFIS) [1], uncontrolled diabetes, and narrow-angle glaucoma [5], in which excessive dilation may increase surgical risks.

Traditional management strategies include pharmacologic or mechanical pupil dilation, such as iris hooks or pupil expansion rings [2-4]. However, these tools may be unavailable, costly, or associated with intraoperative complications [3]. Therefore, developing an alternative technique that is both safe and effective has significant clinical value. This study introduces the under-iris capsulorhexis technique, whereby the capsulorhexis is created beneath the iris margin, using the iris as a stabilizing scaffold to prevent uncontrolled capsule tears, while relying on color contrast for capsule localization [2].

Although numerous techniques exist for managing small pupils-including mechanical devices, pharmacologic agents, and viscoelastic pupil expansion-current approaches have notable limitations. Mechanical devices increase surgical costs and may not be accessible in low-resource settings. Pharmacologic dilation may be insufficient in IFIS [1] or intentionally avoided in narrow-angle glaucoma [5]. Excessive manipulation increases intraocular stress and risks iris trauma or postoperative inflammation. These limitations highlight a clear gap in

current practice and underscore the need for a simpler, lower- cost, and less traumatic alternative. The under-iris capsulorhexis technique aims to bridge this gap by enabling controlled and effective capsulorhexis creation beneath the iris margin without additional mechanical devices or excessive manipulation, offering a practical and safer option for experienced surgeons when managing small pupils.

Objective of the Study

The primary objective of this study is to evaluate the safety, feasibility, and outcomes of under-iris capsulorhexis in small-pupil cases during phacoemulsification [2,4]. The technique aims to reduce the risk of uncontrolled capsular tears and enable safe surgery without reliance on mechanical pupil expansion devices [3,4].

Methods

Study setting: Sudan Eye Center, Khartoum, Sudan.

This is a prospective case series conducted at the Sudan Eye Center, including patients indicated for cataract surgery who presented with insufficient pupil dilation (< 4 mm), age-related cataract, and no history of prior ocular surgery. Exclusion criteria included significant zonular weakness, subluxated lens, history of ocular trauma. This exploratory series included 850 consecutive eyes with small pupils (< 4 mm) that underwent phacoemulsification between 2018 and 2024. There were 600 male and 250 female patients, aged 50 - 75 years (mean age 65).

The cohort included:

- 200 patients with diabetes,
- 500 patients with narrow-angle glaucoma [5],
- 150 patients with IFIS [1].

Because this technique requires substantial surgical expertise, all procedures were performed by a single experienced consultant ophthalmic surgeon under local anesthesia. Standard sterile preparation was followed. The anterior capsule was stained with Trypan Blue to enhance visualization [2]. CCC was initiated beneath the iris after injecting a cohesive viscoelastic agent. The target capsulorhexis diameter was approximately 2 mm larger than the visible pupil. The iris was allowed to gently drape over the capsular edge, acting as a physical barrier that stabilizes the tear margin [3]. No mechanical pupil expansion devices were used in any case [4]. Intraoperative data were recorded, and postoperative follow-up extended for 12 months.

Results

All 850 procedures were successfully completed.

Under-iris capsulorhexis was achieved with excellent control, with a 100% completion rate. No cases of capsular extension, posterior capsule rupture, vitreous loss, or iris trauma were reported.

Postoperative recovery was smooth, with stable intraocular pressure and satisfactory visual outcomes:

- $\geq 6/18$ in 40% of patients.
- $\geq 6/12$ in 60% of patients. Preoperative vision ranged from PL to 6/36 in most cases, and 6/24 to 6/18 in a few cases.

A mild anterior chamber reaction occurred in 1% of cases, resolving within the first postoperative week. No infections or intraocular pressure spikes were recorded during the 12-month follow-up.

The technique demonstrated particular benefit in narrow-angle glaucoma [5], where pharmacologic dilation may increase the risk of angle closure and intraoperative pressure rise, potentially compromising surgical continuation.

Discussion

The under-iris capsulorhexis technique offers a safe and innovative solution for managing small pupils during phacoemulsification [2,4]. By using the iris as a structural support, the risk of uncontrolled capsular tears is reduced [3]. While this method does not eliminate the need for mechanical pupil expanders in all cases, it significantly decreases surgical time, cost, and manipulation-related complications [3,4].

Our results suggest that this technique is particularly suitable for resource-limited settings and for patients in whom pharmacologic or mechanical dilation is contraindicated [4,5]. Although it requires surgical expertise and familiarity with limited-visibility environments, the high success rate and absence of major complications support its practical value.

Small pupils continue to pose a major challenge in cataract surgery, increasing procedural complexity and complication risk. While various management techniques exist, some require additional devices, increase costs, or involve more intraocular manipulation. This case series demonstrates that under-iris capsulorhexis may serve as a safe and effective alternative, minimizing intraocular stress and improving efficiency-especially in centers with limited resources.

Conclusion

The under-iris capsulorhexis technique appears to be a safe, effective, and cost-efficient method for performing continuous curvilinear capsulorhexis (CCC) in eyes with small pupils [2,4]. Its application reduces reliance on mechanical pupil expansion devices and minimizes intraoperative complications, especially in patients with IFIS [1] and narrow-angle glaucoma [5].

We recommend this technique as a valuable addition to the surgical toolbox for complex cataract cases and encourage future comparative studies evaluating its effectiveness versus mechanical expansion devices.

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