REVIEW

Suture-Based Surgical Techniques for Iris Reconstruction: A Comparative Review with Clinical Case Examples

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ABSTRACT

Objective: This study presents a narrative review combined with a retrospective case series evaluating the efficacy, safety, and outcomes of different surgical techniques used for iris reconstruction.The surgical approaches were analyzed in terms of pupil centration, anatomical restoration, visual function, and cosmetic outcomes.

Methods: A narrative review was conducted on commonly used pupilloplasty techniques including the Siepser sliding knot, McCannel, Single-Pass Four-Throw (SPFT), pupil cerclage, and iris hook segment methods. The advantages, limitations, and indications of each technique were summarized based on existing literature. Additionally, five clinical cases from our institution are presented to highlight technique selection in real-world scenarios.

Results: Each iris reconstruction technique demonstrated specific advantages depending on the extent of iris damage, surgical complexity, and postoperative stability. The Siepser slipknot technique provided excellent pupil centration with minimal trauma, while the pupil cerclage technique achieved optimal circularity in cases of traumatic mydriasis. The SPFT technique allowed for efficient suture placement with reduced intraocular manipulation, whereas the McCannel technique was effective for post-cataract pupil defects. Postoperative pupil shape and function were successfully restored in all cases, with no severe complications observed.

Conclusion: Different pupilloplasty techniques offer unique benefits depending on the clinical scenario. The suture selection and surgical approach play a crucial role in achieving optimal anatomical and functional outcomes.

Keywords: Pupilloplasty, iris reconstruction, iris suturing techniques, pupillary cerclage

INTRODUCTION

The iris plays a vital role in regulating light entry into the eye, and contributes to both visual function and ocular aesthetics[1]. Trauma, surgical complications, congenital anomalies, and degenerative conditions can lead to iris defects, resulting in symptoms such as glare, photophobia, reduced contrast sensitivity, and cosmetic concerns [2–5].

Iris reconstruction surgery, a specialized surgical intervention, aims to reconstruct the pupil and iris, restore functional vision, and improve the overall appearance of the eye [6]. Recent advancements in microsurgical techniques have expanded the range of available procedures, allowing surgeons to tailor interventions based on the specific characteristics of each case [7].

A variety of iris reconstruction techniques have been developed to address different types of iris defects. Methods such as the Siepser sliding knot technique, McCannel technique, McAhmed technique, Single Pass Four Throw technique, and pupillary cerclage method each offer unique advantages depending on factors such as the size and location of the iris defect, presence of aphakia or pseudophakia, associated ocular pathologies, and patient-specific needs [8–10]. While some techniques prioritize functional improvements such as reducing glare and photophobia, others focus on optimizing cosmetic outcomes or facilitating intraocular

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lens (IOL) implantation [7]. For clarity, in this manuscript "pupilloplasty" refers to suture-based repair of the pupil margin; "iridoplasty" denotes general repair of the iris tissue; and "iris reconstruction" is used as an umbrella term encompassing all surgical techniques aimed at restoring iris anatomy and function.

This review provides a comparative evaluation of commonly used iris reconstruction techniques, supported by five illustrative clinical cases. By analyzing pre- and postoperative findings, the study outlines the indications, advantages, and limitations of each method. The aim is to inform surgical decision-making and enhance both functional and aesthetic outcomes in patients with iris abnormalities.

Material and Methods

This hybrid design combines a narrative review of the literature with a retrospective analysis of five cases performed at the Fırat University Ophthalmology Department between 2024 and 2025. All procedures were conducted by a single experienced surgeon (M.E.) under standardized surgical conditions. The selection of technique was determined based on the type, extent, and location of the iris defect, as well as the presence of coexisting ocular pathologies such as aphakia or previous vitrectomy. Preoperative and postoperative clinical findings—including visual acuity, pupil morphology, and complications—were retrospectively collected and reviewed. Informed consent was obtained from all patients for the scientific use of their clinical data and surgical images. The study protocol was reviewed and approved by the Ethics Committee of Fırat University Medical Faculty (Approval No: 2025/07-03), in accordance with the principles outlined in the Declaration of Helsinki.

Conservative and Surgical Management Strategies for Iris Defects

The management of iris defects can be broadly categorized into conservative and surgical approaches, depending on the severity of the defect, patient symptoms, and functional or cosmetic demands.[10–12]. In selected cases, non-surgical methods may provide temporary or partial relief, while surgical reconstruction remains the gold standard for anatomical restoration and long-term visual improvement. Treatment options range from conservative approaches to surgical reconstructions.

Conservative Approaches

Colored contact lenses are commonly used to mask iris defects by simulating pupil size and iris pigmentation, thereby reducing photophobia and improving cosmetic appearance. [11,13] However, these lenses carry an inherent risk of infectious keratitis, particularly with extended use or poor hygiene practices.[14] Additionally, adaptation may be difficult in eyes with irregular corneal surfaces or post-traumatic corneal scarring.[11] Some commercially available iris-printed lenses have also shown limited effectiveness due to transparency issues or poor centration, potentially leading to visual distortion or discomfort.[4]

Sunglasses and photochromic glasses represent another conservative strategy, offering temporary reduction in light sensitivity and glare by limiting ambient light transmission. While simple and non-invasive, these methods do not address the underlying optical aberrations caused by iris deformities.

Corneal tattooing (keratopigmentation) has been proposed as a minimally invasive method to improve both cosmetic appearance and light control in selected cases of aniridia or large iris defects.[15] Nonetheless, the procedure is not without risks. Reported complications include granulomatous keratitis, iridocyclitis, and persistent epithelial defects, particularly when non-biocompatible pigments are used or in eyes with compromised ocular surfaces.[16]

Pharmacologic approaches such as the use of miotic agents aim to reduce pupil size and limit photic symptoms. However, in eyes with residual iris tissue syndrome (RITS) or extensive sphincter damage, these agents have shown limited effectiveness in improving light modulation or symptom relief.[17]

Surgical Reconstruction

Surgical approaches remain the mainstay for definitive management of significant iris defects. These procedures aim to restore the integrity and function of the iris, normalize pupil size and shape, and, in some cases, implant artificial iris devices to simulate natural anatomy. Depending on the extent of the defect and available resources, options include suture-based pupilloplasty techniques, iris prosthesis implantation, or hybrid methods combining intraocular lens fixation with iris repair.7 Surgical reconstruction offers

superior outcomes in terms of light control, cosmetic restoration, and patient satisfaction, although it may involve higher technical complexity and risk of postoperative complications.[18]

Iris Prosthetics / Artificial Iris (AI) Devices: Prosthetic iris devices (PIDs) are designed to restore both functional and cosmetic integrity in cases of large iris defects or aniridia.[11] They are typically classified into three main types: iris-lens diaphragm prostheses, capsular tension ring (CTR)-based modifications, and customized artificial iris implants.[19] These devices can correct both aphakia and iris defects in a single procedure by integrating with intraocular lenses.[20] Implantation techniques include placement within the capsular bag[11], ciliary sulcus implantation, scleral suture fixation, and open-sky approaches during keratoplasty.[21] Artificial iris implantation generally improves visual acuity[22], reduces glare and photophobia[7], and enhances contrast sensitivity.[23] However, limitations such as fixed pupil size affecting posterior segment examination and potential complications like glaucoma or suture erosion should be carefully considered.

Suture-Based Iris Reconstruction: These surgical techniques remain fundamental, particularly in cases where sufficient iris tissue is present. These methods are preferred for their ability to preserve native tissue, provide functional and cosmetic restoration, and avoid more invasive alternatives.[7]

Suture-based iris reconstruction techniques, commonly referred to as pupilloplasty, are typically indicated in patients with sectoral iris defects involving 2–3 clock hours[24], iridodialysis[25], or persistent traumatic mydriasis.[26] When adequate residual iris tissue is available, these techniques offer the advantage of minimal invasiveness, cost-effectiveness, and preservation of native ocular anatomy.[27] However, their applicability diminishes in the presence of large or total iris defects. Additional limitations include increased operative time potential tissue trauma due to manipulation, suture breakage, and challenges in achieving a completely occlusive and light-blocking pupillary margin.[26,28]

Overview of Commonly Used Techniques

McCannel Technique: Originally described in 1976, this method involves external knot tying via limbal incisions using a double-armed 10-0 polypropylene suture.[8] It is particularly useful for repairing iridodialysis. While technically straightforward and widely practiced, the need for external knot tying may complicate precise tensioning and centration.[29]

Shin Technique: Originally described as a modification of the McCannel suture method,[9] the Shin technique involves the use of two limbal paracenteses and a 25-gauge, hypodermic needle attached to a tuberculin syringe. The needle is introduced through one paracentesis and advanced through both proximal and distal edges of the iris from anterior to posterior. It is then externalized via the opposite paracentesis. After withdrawal of the needle, a 10-0 polypropylene suture is retrieved using a Sinskey hook through a stab incision, and the suture ends are tied and buried. While the technique requires precise intraocular maneuvers, it offers a controlled and anatomical*ly oriented method of iris tissue approximation.*[7]

Siepser Sliding Knot Technique: This closed-chamber technique enables internal knot tying with a sliding knot, minimizing corneal manipulation and reducing the risk of wound-related complications. [29,30] It is ideal for small iris defects and traumatic mydriasis. However, it requires advanced microsurgical skills and careful tension control.

Single-Pass Four-Throw (SPFT) Technique: The SPFT method facilitates rapid and stable closure using a single needle pass followed by a four-throw locking loop.[31] It provides excellent knot security and shortens surgical time. Nevertheless, once tied, the knot cannot be adjusted, making initial positioning critical.

Iris Cerclage Technique: Designed for large, dilated pupils or diffuse sphincter atony, this technique involves a circumferential 360° suture around the pupillary border. It enables the surgeon to recreate a round, centered pupil with precise diameter control.[32] The trade-off is a technically demanding and time-consuming procedure with greater risk of iris trauma.[26]

Mattress Suture Technique: By distributing radial tension across the iris tissue, the mattress suture technique provides stable fixation and improved pupillary contour in medium-sized defects; however, due to the parallel suture placement, it may occasionally result in visible suture tracks on close examination. [33]

Sewing Machine Technique: This method emulates the motion of a sewing machine, with multiple back-and-forth suture passes across the iris tissue. It is advantageous in linear defects and, when performed with proper spacing and tension control, can provide secure fixation with minimal tissue trauma.[34]

Cobbler's Technique: Originally developed for iridodialysis repair, this method is a variation of the sewing machine approach.[35] It involves creating a partial-thickness scleral tunnel and passing multiple looped sutures to secure the iris root to the scleral wall. Although this technique provides effective stabilization and generally favorable cosmetic results, its use is less common due to technical complexity and limited comparative evidence. [7]

Hangback Technique: Initially described by Snyder and Lindsell, the hangback technique is a non-appositional method used primarily for the repair of small iridodialysis defects (<3 clock hours).[36] It involves suspending the iris root to the scleral wall using a double-armed suture without drawing it tightly against the sclera, allowing for controlled positioning rather than passive repositioning. Although the technique provides a tension-controlled fixation that helps preserve anterior chamber angle anatomy and minimizes the risk of peripheral anterior synechiae, its effectiveness in achieving a well-centered and regular pupil may vary depending on defect size and tissue loss. When properly applied, it offers a stable and anatomically favorable outcome with reduced trauma and the potential for scleral burial of knots to minimize suture visibility.[37]

Iris Retractor Segment Technique: This novel technique involves securing a trimmed segment of a disposable iris retractor to the sclera using a single suture passed through the iridodialysis edge. The segment supports the detached iris like a scaffold, allowing efficient closure of large defects with minimal intraocular manipulation. Multiple segments can be used for extensive dialysis.[38]

Each technique offers distinct advantages based on the defect's size, location, and the surgeon's expertise. While no single method is universally superior, a tailored approach considering patient-specific anatomical and visual requirements remains essential. Continued comparative studies and surgical refinements are needed to standardize outcomes and optimize patient satisfaction in iris reconstruction.

Case Series

Case 1

A 56-year-old female presented with complaints of decreased vision and cosmetic discomfort in her right eye, secondary to trauma sustained at age 10. Preoperative ophthalmic examination revealed a visual acuity of hand motions in the right eye and 0.7 in the left eye with Snellen chart. Intraocular pressure (IOP) for both eyes, were 12mm Hg. The anterior segment evaluation of the right eye showed a nasally displaced pupil obstructing the optical axis and the presence of cortico-nuclear cataract. The fundus was unremarkable in visible areas. The left eye exhibited early-stage cataract, with an otherwise normal fundus.

A cataract extraction and pupilloplasty were planned for the right eye. The procedure was performed under local anesthesia. Following cataract extraction, a posterior chamber IOL was implanted into the capsular bag. Residual viscoelastic material (OVD) was aspirated using an irrigation/aspiration (I/A) system. To optimize postoperative pupil positioning, miostat (carbachol) was administered for miosis. Endodiathermy was used to reposition the temporal section of iris, followed by pupilloplasty using the Siepser sliding knot technique. The surgery concluded with the removal of residual OVD from the anterior chamber.

Postoperatively, the patient was prescribed topical antibiotics for one week and topical steroids for two weeks. At the one-week follow-up, the visual acuity of the right eye had improved to 0.7 on the Snellen chart (Figure 1). No complications were observed during the long-term follow-up period.

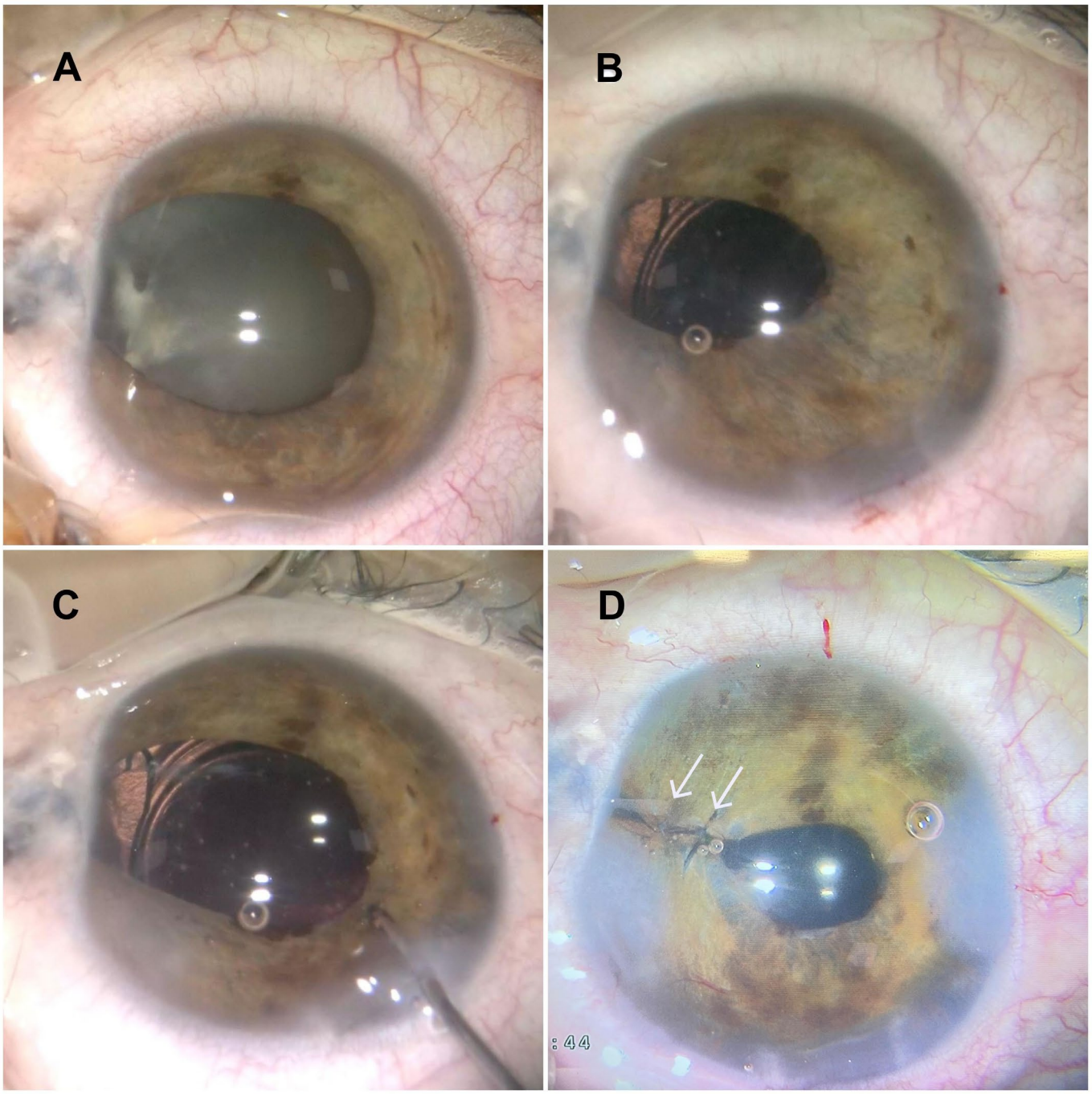

Figure 1: *Preoperative temporal displacement of the pupil (A); intraoperative view after IOL implantation (B); centralization using nasal traction with endodiathermy (C); and final postoperative appearance at the end of surgery, the white arrows show sutures (D).*

Case 2

A 69-year-old male was referred with complaints of reduced vision in the left eye, one week after complicated cataract surgery. Preoperative examination revealed a visual acuity of 0.6 in the right eye and 0.1 in the left eye with Snellen chart. The anterior segment evaluation showed nuclear sclerosis in the right eye and pseudophakia in the left. A iris defect was noted near the phacoemulsification main incision site, with residual cortical material beneath the IOL, obstructing the visual axis. The IOP was 14 mmHg in the right eye and 12 mmHg in the left. The right eye fundus was unremarkable, while the left eye exhibited a pigmented crescent-shaped lesion nasal to the optic disc.

An anterior chamber lavage and iridoplasty were planned for the left eye. Preoperatively, the patient was started on topical nonsteroidal anti-inflammatory medication (five times daily). During the surgery, anterior chamber staining with triamcinolone was performed to assess vitreous traction, followed by meticulous removal of residual cortical material. Miostat (carbachol) was administered to induce miosis, and a PC 9.0 (Alcon) suture was placed in the iris at two clock-hour positions on either side of the primary incision. The suture ends were externalized through the phacoemulsification incision using microforceps and secured with the McCannel technique, followed by tying with the McAhmed technique (Figure 2). Then, the Residual viscoelastic material was removed via I/A, and a subconjunctival injection of antibiotics and steroids was administered. On the first postoperative day, the patient's visual acuity improved to 0.5, with a well-centered pupil and no complaints of glare. Postoperative treatment included topical antibiotics (five times daily for one week) and topical steroids (tapered over two weeks). At the final follow-up visit, the patient remained stable with no adverse events or additional complaints noted.

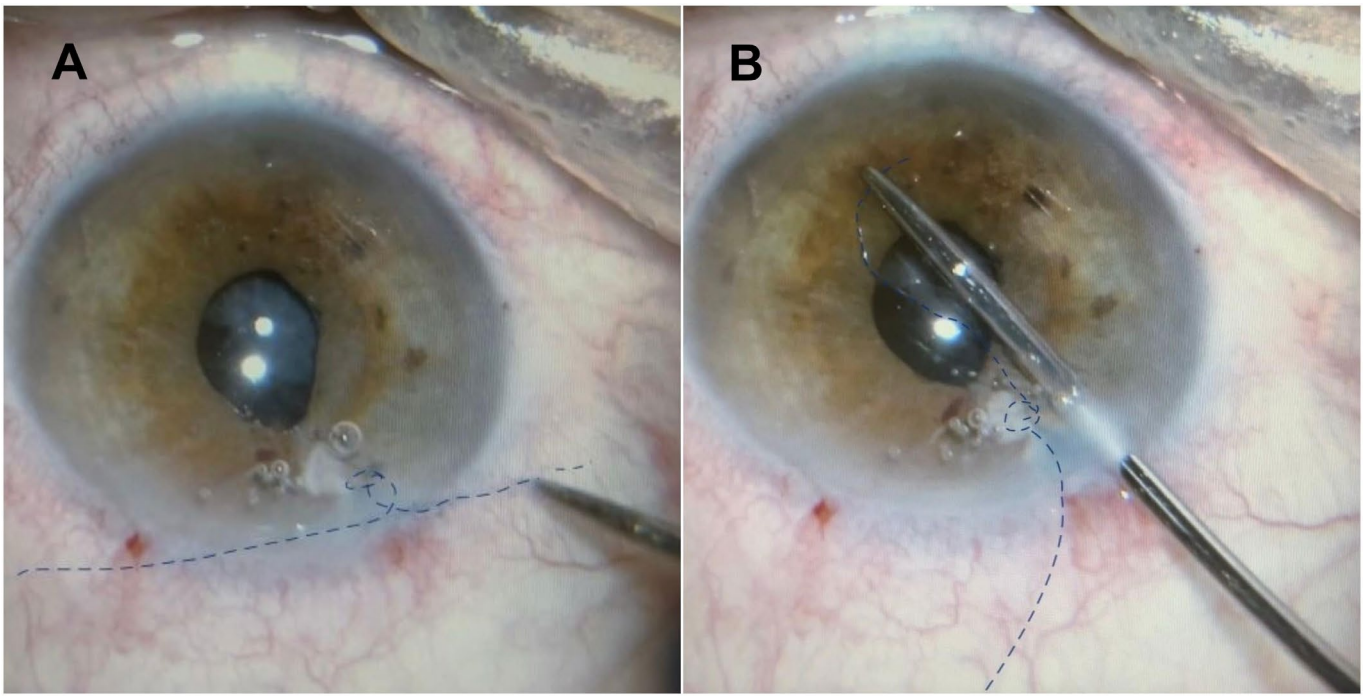

Figure 2: *Placement of the first two sutures with the McCannel technique (A); and final knotting performed using the McAhmed technique (B). Please note, the interrupted lines show the suture track.*

Case 3

A 12-year-old male with a history of eye surgery at age 7 due to trauma presented with an unclear medical history due to a language barrier. Preoperative visual acuity was 0.3 (-2.00x132) in the right eye and 1.0 in the left eye with Snellen chart. The Anterior segment examination revealed a defective pupil and posterior subcapsular opacification in the right eye, while the fundus was normal.

Due to financial constraints, an artificial iris prosthesis was not feasible. Therefore, monofocal + IOL(Eyhance, J&J) implantation and iridoplasty were planned. The procedure was performed under general anesthesia. Intraoperatively, the iris pigments were cleaned from the anterior capsule, followed by capsulorhexis, phacoemulsification, and IOL implantation. Pupilloplasty was performed using the Single Pass Four Throw technique (Figure 3).

On the first postoperative day, visual acuity in the right eye improved to 1,0. Postoperative management included topical antibiotics and steroids, tapered over several weeks. The patient's condition remained stable throughout long-term follow-up, with no recurrence of symptoms or surgical complications.

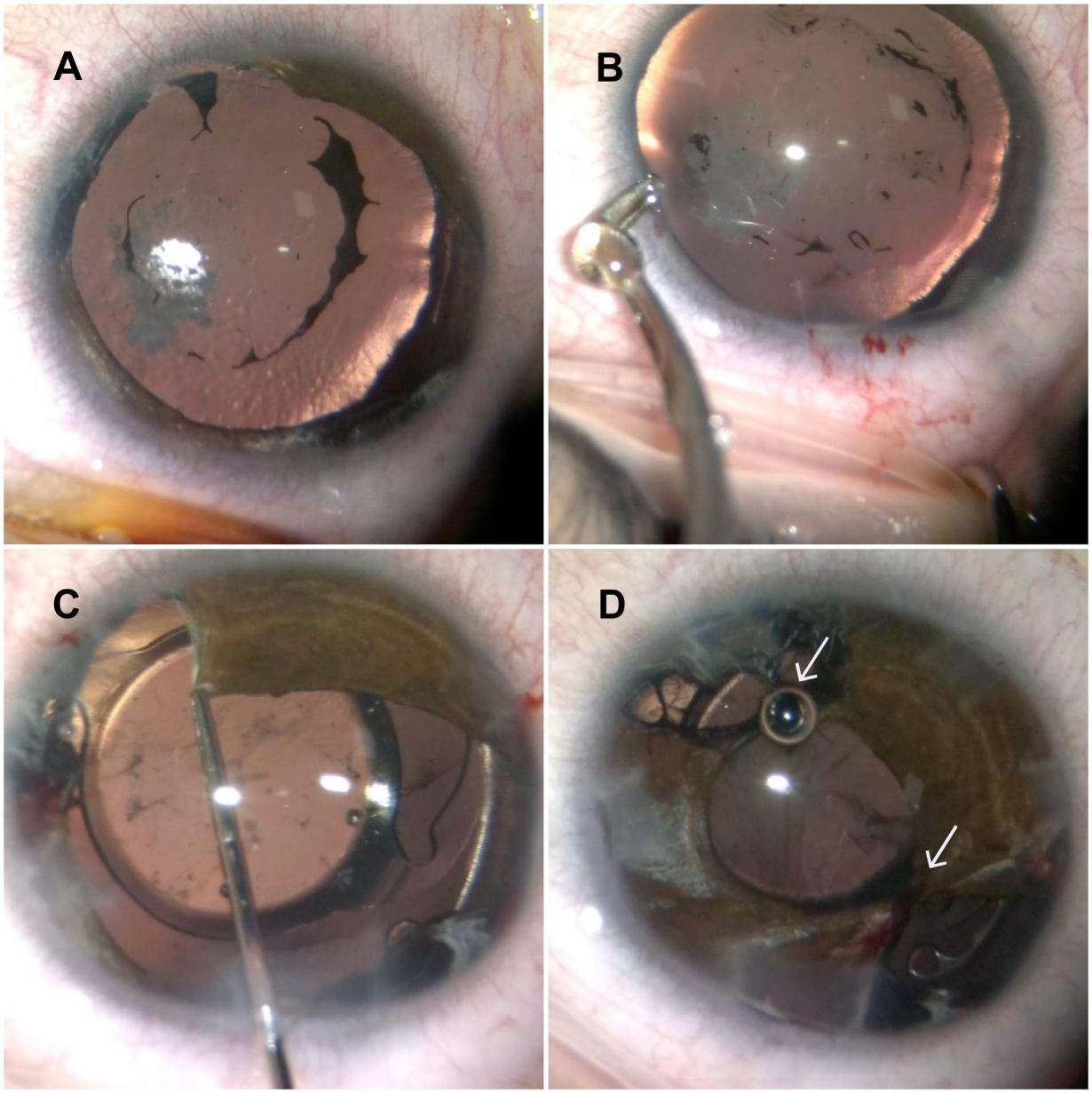

Figure 3: *Preoperative anterior segment showing iris defect (A); removal of adherent iris pigment from the anterior capsule (B); assessment of residual iris tissue before suturing (C); and creation of a centered functional pupil (D), the white arrows show sutures.*

Case 4

A 64-year-old male, with a history of pars plana vitrectomy due to blunt trauma resulting in aphakia presented for further management. The Preoperative visual acuity was 0.1 (+10 D correction) in the right eye and 0.8 in the left with Snellen chart. The right eye exhibited a fixed dilated pupil.

The patient underwent a scleral fixation and a three-piece IOL used with the Yamane technique, combined with pupillary cerclage under a sub-Tenon anesthesia. The iris was divided into four quadrants to facilitate suturing with PC 9.0 sutures. The McAhmed technique was applied for knot tying. The pupil size was left with an approximate 3.5 mm opening. Postoperative imaging at week one revealed no clinically appreciable anisocoria, with both pupils appearing symmetric in size (Figure 4).

At the first postoperative week, visual acuity in the right eye improved to 0.7. Postoperative treatment included topical steroids (tapered over two weeks) and antibiotics (five times daily for two weeks). Over the course of follow-up, the patient maintained stable visual acuity and anatomical outcomes, with no need for additional intervention.

Case 5

A 71-year-old male, who had previously undergone scleral wound repair for penetrating ocular trauma and, developed iridodialysis in the left eye. He had presented with complaints of blurred vision and photophobia. The preoperative visual acuity was 0.7 in the right eye and 0.1 in the left with Snellen chart. The Anterior segment evaluation showed an iridodialysis extending over 3-4 clock hours in the nasal region, along with a nuclear cortical cataract.

The patient underwent an iridodialysis repair and a cataract surgery under a retrobulbar anesthesia. Phacoemulsification surgery was performed with the aid of iris hooks. A 3 mm segment of the trimmed iris hook was used for repositioning, secured with 9-0 polypropylene sutures. After inducing miosis with Miostat, a 27-gauge insulin needle was inserted into the sclera 1.5 mm posterior to the limbus at the site of iridodialysis. The PC 9.0 suture needle was then guided underneath the iris and retrieved through the scleral entry point using the insulin needle as a guide. The iris was further stabilized with microforceps. OVD removal was performed manually to maintain anterior chamber stability (Figure 5).

At the first postoperative week, visual acuity improved to 0.4, with stable iris positioning. Standard postoperative management was followed, and the patient was scheduled

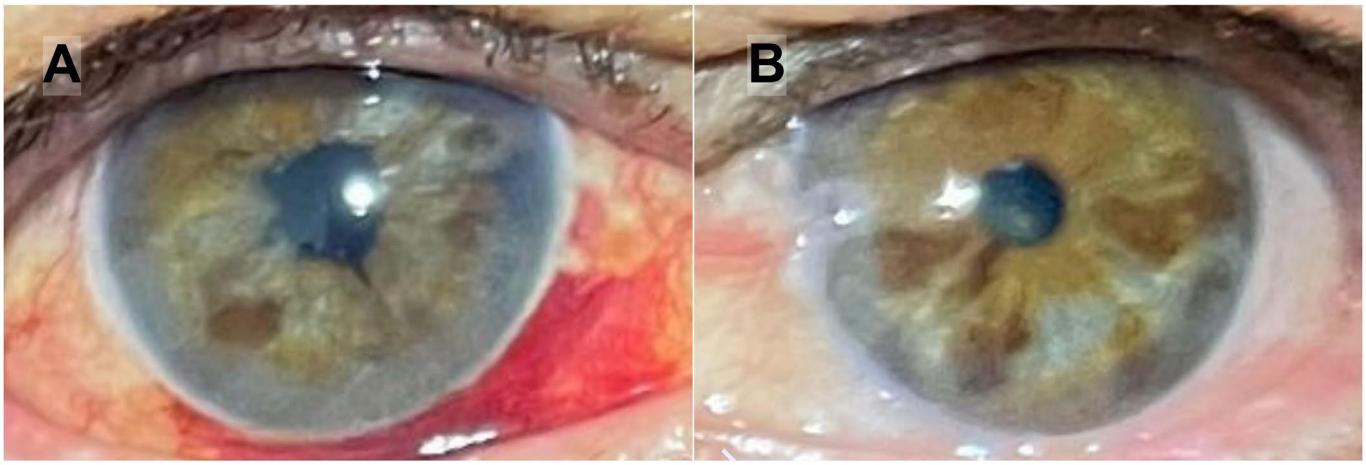

Figure 4: *Postoperative appearance demonstrating symmetric pupils one week after the right eye pupillary cerclage.*

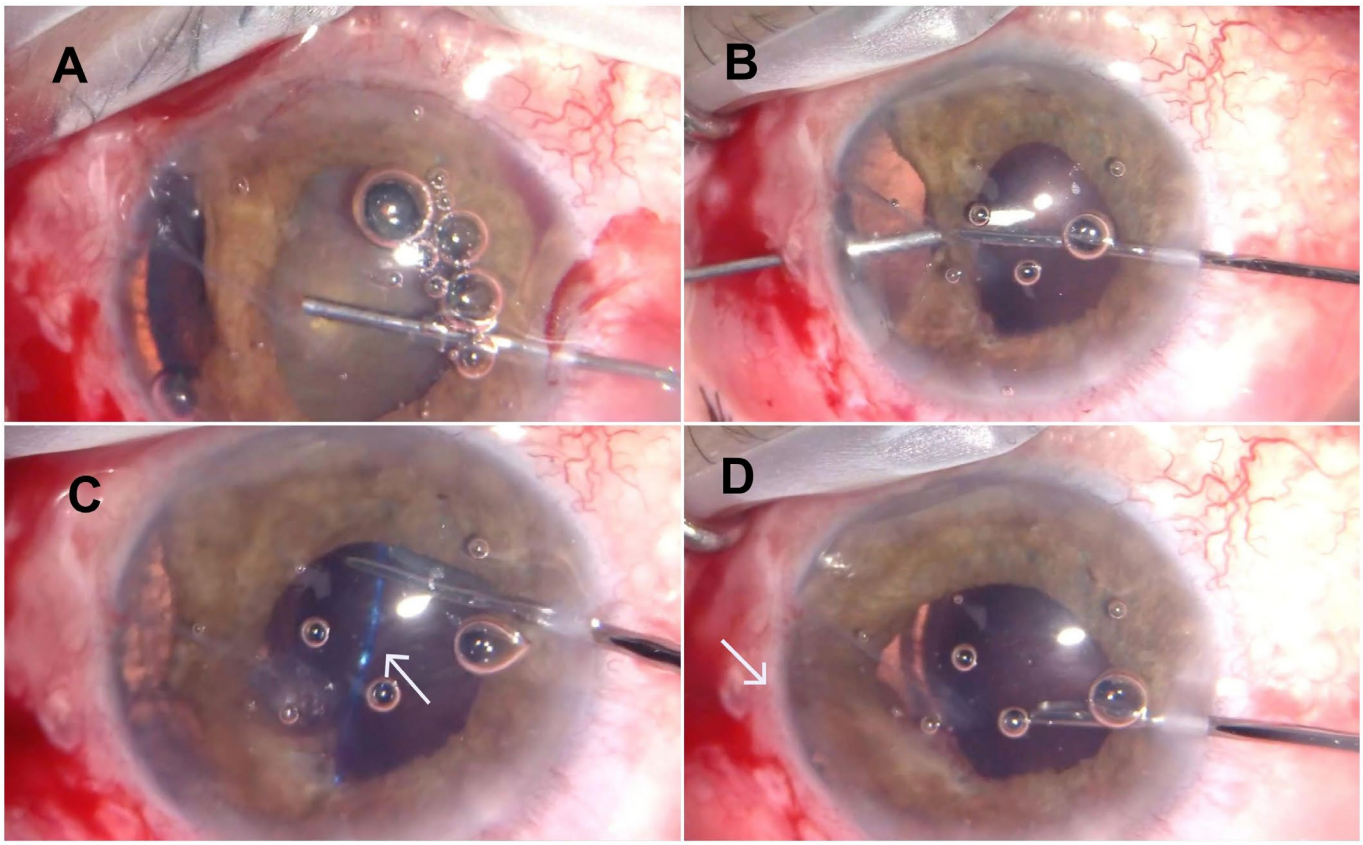

Figure 5: *Preoperative temporal iridodialysis (A); passage of a polypropylene suture through the iris using a 27-gauge needle as a guide (B); placement of a trimmed iris retractor segment (the white arrow) beneath the iris tissue (C); and intraoperative adjustments with micro-forceps to optimize pupil centration and closure of the dialysis (the white arrow) (D).*

for ongoing ophthalmologic follow-up. During extended follow-up, the patient demonstrated satisfactory anatomical and functional recovery with no procedure-related complications.

Discussion

Iris reconstruction surgery is a surgical procedure designed to restore the iris and pupil while enhancing both visual function and cosmetic appearance. Various techniques are available for iris reconstruction, each suited to different clinical scenarios. This study evaluated five cases undergoing different pupilloplasty methods and highlighted their respective advantages and limitations.

Types of iris trauma include traumatic mydriasis, iris sphincter tears, iridodialysis, iris prolapse, and traumatic iritis[39]. Traumatic aniridia, in particular, results from a rupture at the iris root, leading to partial or complete loss of iris tissue through a scleral or corneal wound. While commonly associated with penetrating trauma, it can also occur in blunt trauma due to a sudden rise in intraocular pressure, causing a rupture at the point of least resistance.[40] Various studies indicate that ocular trauma frequently leads to iris damage, which is a common yet often overlooked aspect of ocular injuries. In cases of severe blunt trauma, iris or pupillary abnormalities have been reported in approximately 37% of affected eyes.[41] Among patients with ocular contusion or globe rupture, iridodialysis in 10%, traumatic aniridia in 1%, and iris sphincter tears occur in 20% of cases, while in open globe injuries, iridodialysis has been observed in approximately 41% of cases. [42–44]

There are various methods available to address iris deficiencies, each tailored to the severity of the defect and the individual needs of the patient. Surgical reconstruction of the iris is one of the most direct approaches, aiming to restore the anatomical structure and improve both functional vision and cosmetic appearance. For patients seeking

non-surgical alternatives, cosmetic colored contact lenses can provide an effective means of masking iris defects while improving visual comfort. Corneal tattooing, another minimally invasive option, involves applying pigment to the cornea to simulate a natural iris, offering a permanent cosmetic solution in selected cases.[45] For more complex cases, particularly where extensive iris loss is present, intraocular iris implants can be inserted can use to reconstruct the iris diaphragm, restore the pupillary aperture, and improve light regulation within the eye. [19]

The choice of technique depends on factors such as the extent of iris loss, the presence of other ocular injuries, the patient preference, and the desired balance between function and cosmesis. In our study, we focused on evaluating different suturing techniques for iris reconstruction in terms of anatomical restoration, functional outcomes, aesthetic improvement, and long-term stability, providing a comprehensive comparison of their advantages and limitations No cases of hypotony, conjunctival erosion, knot loosening, suture-induced iris distortion, or endophthalmitis were observed throughout the follow-up period.

The Siepser sliding knot technique, as used in Case 1, was particularly effective for repositioning a displaced pupil secondary to trauma. This approach is commonly favored due to its minimally invasive nature and ability to create a well-centered, round pupil. This technique is a closed-chamber suturing method used for iris reconstruction, particularly in cases of iridodialysis, traumatic mydriasis, and iris coloboma. Introduced as a modification of the McCannel technique, this method allows surgeons to tie a sliding knot outside the eye and then secure it inside the anterior chamber while maintaining its stability. The Siepser slipknot minimizes surgical trauma by using only two small corneal incisions, reducing intraocular manipulation and ensuring a more controlled repair. The procedure involves passing a 10-0 polypropylene suture through the anterior chamber, followed by the use of a microhook to guide a loop of suture through the opposite side of the iris defect. The knot is then tied externally and gently slid into place over the iris tissue by pulling the suture ends. This technique provides excellent tension control, ensuring precise approximation of the iris without excessive distortion. The Siepser slipknot technique offers several advantages, including achieving better cosmetic and functional results. However, it requires technical expertise, as improper tensioning may lead to pupillary distortion or over-tightening. Despite its learning curve, the technique has gained widespread acceptance in iris repair and intraocular lens fixation, making it a valuable tool for ophthalmic surgeons performing complex anterior segment reconstructions.[10,30]

Additionally, the application of endodiathermy in this case facilitated optimal iris positioning, reducing the risk of postoperative asymmetry. Endothermal pupilloplasty (EDP), was applied before suturation to centralize the pupil by inducing controlled thermal contraction of the iris stroma using bipolar microendodiathermy. Unlike traditional methods such as microscissors, vitrectors, or laser photocoagulation, EDP allows precise adjustment of pupil size and contour while preserving iris tissue integrity and minimizing trauma. This approach facilitated the creation of a smooth, round, and well-centered pupil, improving both functional and cosmetic outcomes while ensuring long-term stability in iris reconstruction.[46] The improvement in visual acuity from hand motion to 0.7 further underscores the efficacy of this technique.

In Case 2, where the patient experienced a pupil defect following a complicated cataract surgery, a combination of the McCannel and the McAhmed techniques was utilized. These techniques ensured a stable pupil reconstruction and prevented light scatter-related visual disturbances. The McCannel suturing technique, first introduced in 1976 [8], is a fundamental method in iris reconstruction surgery, commonly used for iris defects, iridodialysis, traumatic mydriasis, and pupilloplasty. This technique involves making two small corneal incisions perpendicular to the iris defect and an additional stab incision in the peripheral cornea to assist with suture manipulation. A 10-0 polypropylene suture is passed through the iris using a curved needle, and a microhook is then used to retrieve both suture ends through the stab incision.[32] The knot is tied outside the eye and carefully slid back into the anterior chamber, allowing for precise control over iris reapproximation**.** Despite its effectiveness, the McCannel technique requires three incisions and involves significant intraocular manipulation, which can increase the risk of inflammation in complex cases. While newer techniques have been introduced, the McCannel technique remains a widely used and reliable method for direct iris suturing, offering good functional and cos-

metic outcomes in iris reconstruction procedures.[47] The incorporation of triamcinolone staining proved instrumental in identifying residual vitreous, thereby preventing further complications such as cystoid macular edema. This case highlights the importance of meticulous anterior chamber management in post-cataract surgery pupillary defects.

The case 3 presented unique challenges as the patient was a pediatric trauma case with financial constraints, limiting access to an artificial iris prosthesis. In such cases, alternative pupilloplasty techniques must be employed. The SPFT technique provided a functional and aesthetically acceptable outcome, demonstrating its viability as a cost-effective solution. The SPFT technique is a modified pupilloplasty method designed to improve iris reconstruction by creating a self-locking suture configuration. Unlike traditional methods such as the Siepser slipknot technique, which require multiple suture passes and knot tying, the SPFT technique involves a single needle pass through the iris defect, minimizing intraocular manipulation. The suture is looped four times, forming a helical configuration that prevents slippage without the need for an additional securing knot. This approach reduces the risk of suture loosening, ensures a strong and stable repair, and eliminates excess bulk inside the anterior chamber. Additionally, avoiding external knot tying lowers the likelihood of postoperative inflammation and tissue trauma. By providing a more secure and efficient method for iris tissue approximation, the SPFT technique represents a valuable advancement in minimally invasive pupilloplasty.[48] However, pediatric cases often require longer follow-ups to monitor for potential suture dehiscence or pupil irregularities due to ongoing ocular growth.

Although we were unable to apply it to this patient due to financial constraints, artificial iris models are widely used to restore visual function and improve cosmetic appearance in patients with traumatic aniridia or iris deficiencies. These prosthetic iris devices (PIDs) are categorized into three main types: AI-IOL prostheses, which combine an artificial iris with an intraocular lens to correct both aniridia and aphakia; endocapsular capsular tension ring (CTR)-based prostheses**,** designed for implantation in the capsular bag or ciliary sulcus; and customizable artificial irides, which offer realistic iris textures and better aesthetic integration. Surgical implantation techniques vary depending on the degree of iris deficiency and aphakia status, with options including scleral suturing, sulcus fixation, and capsular bag implantation. Overall, foldable and customizable prostheses provide superior cosmetic and functional outcomes compared to older, rigid models, and their selection depends on the patient's functional needs, preexisting ocular conditions, and surgical feasibility.[49]

For aphakic patients such as Case 4, a combination of scleral-fixated IOL implantation using the Yamane technique and a pupillary cerclage offered significant functional improvements. The pupillary cerclage method, which involved segmental suturing of the iris, created a physiologically adequate pupil size while allowing sufficient visualization for fundus examination. The pupil cerclage technique is a surgical method used in pupilloplasty to restore a functional and cosmetically acceptable pupil in cases of traumatic mydriasis, where the pupil remains permanently dilated due to iris sphincter damage. This technique involves passing a continuous 10-0 polypropylene suture around the pupillary margin through four anterior chamber paracenteses, ensuring even distribution and a smooth, circular pupil contour. A sliding knot is used to secure the suture, allowing for precise control over pupil size without excessive traction on the iris tissue. Compared to interrupted sutures, which may create an irregular or cat's eye–shaped pupil, the cerclage technique provides a more natural, round shape while minimizing the risk of suture failure or postoperative complications. Additionally, it offers functional benefits, such as reducing glare and photophobia, and is easier to remove if adjustments are needed. Although technically demanding, the pupil cerclage technique is a reliable and effective approach for iris reconstruction, providing optimal visual function, cosmetic outcomes, and improved anterior segment functionality while reducing postoperative glare.[50]

In Case 5, where the patient underwent iridodialysis repair using an iris retractor segment, suturing was performed to restore iris continuity. This minimally invasive technique involves cutting a segment from a disposable iris retractor and using it as a support structure during repair. The retractor segment acts as a pillow, allowing for more iridodialysis closure at once, reducing the need for multiple sutures and excessive tissue manipulation. The surgical steps include a limbal peritomy, side-port incisions, viscoelastic injection, and passing a PC-9 prolene suture under the iris to secure the segment in place. The segment is positioned parallel to

the iridodialysis defect and sutured to the sclera, while the suture ends are buried to avoid erosion and postoperative complications.[38]

This approach is particularly effective for large iridodialysis cases, as it minimizes intraocular handling, shortens surgical time, and reduces the risk of complications. Unlike conventional suture-based techniques, this method allows for titration of suture tension, preventing peripheral anterior synechia and secondary angle-closure glaucoma. Additionally, using fewer sutures decreases the likelihood of suture erosion and conjunctival irritation. In contrast, the sewing machine technique uses multiple looping suture passes to secure the iris, providing effective stabilization but requiring more intraocular manipulation.[34]

The choice of surgical technique was primarily determined by the type, extent, and location of the iris defect, along with the patient's overall ocular status, such as aphakia, prior vitrectomy, or zonular integrity. Pupil cerclage was favored in cases of extensive sphincter damage and traumatic mydriasis due to its capacity to restore a round, symmetric pupil. In contrast, the SPFT and Siepser techniques were preferred for sectoral defects, offering minimal manipulation and effective centration. Despite their respective advantages, each method has limitations: the Siepser slipknot may risk over-tightening or slippage if not meticulously performed; the cerclage technique requires precise suture tensioning to avoid ovalization; and the SPFT approach, while minimally invasive, may offer limited control in larger defects. A critical understanding of these nuances is essential for tailoring the surgical approach to individual anatomical and functional needs. In Table 1, iris reconstructions techniques summarized with their specifications.

In some cases, the choice of surgical technique was influenced by financial limitations, which precluded the use of artificial iris implants despite clinical indications. This reflects a common real-world constraint in ophthalmic surgery and emphasizes the importance of having cost-effective yet functionally reliable alternatives, such as suture-based pupilloplasty methods. Future healthcare planning and research should take into account the accessibility of high-cost interventions in low-resource settings.

This study is limited by its retrospective nature and the absence of standardized quantitative outcome measures such as postoperative pupil diameter, contrast sensitivity testing, or validated patient satisfaction questionnaires. Future prospective studies incorporating these metrics are warranted to provide more robust evidence.

In conclusion, this study underscores the versatility and adaptability of modern iris reconstruction and pupilloplasty techniques, each of which has specific indications. Beyond technique selection, preoperative planning, intraoperative modifications, and postoperative management play crucial roles in optimizing functional and aesthetic outcomes. The choice of technique should be tailored based on the extent of iris damage, the presence of concurrent ocular pathologies, and patient-specific factors such as financial

Table 1: *Comparison of iris suturing techniques for iridodialysis and pupilloplasty repair*

Feature	Iris Retractor Segment Technique[50]	Sewing Machine Technique[34]	McCannel Technique[8]	Siepser Slipknot Technique[29,30]	Single-Pass Four-Throw (SPFT) Technique[31]	Pupil Cerclage Technique[26]
Approach	Uses a precut iris retractor segment as structural support	Uses a continuous looping suture technique similar to a sewing machine	Uses externalized sutures tied outside the eye and slid into the anterior chamber	Uses a closed-chamber sliding knot technique	Uses a self-locking, knotless suture in a single pass	Uses a continuous circumferential suture to restore a round pupil
Surgical Complexity	Less intraocular handling, ideal for large iridodialysis	Requires multiple loops but is relatively simple	Requires three incisions and external knot tying	Technically more demanding, as sliding knots require precision	Minimally invasive, no external knot tying	More complex, as it requires uniform suture tension around the pupil

continued...

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Effectiveness for Large Iridodialysis	Highly effective (requires fewer sutures)	Suitable for moderate defects, but requires more loops and handling	Effective for moderate iris defects	Effective for small to moderate defects, allows adjustable pupil size	Good stability, minimizes chamber instability	Ideal for traumatic mydriasis, provides excellent centration
Risk of Complications	Lower risk of synechia and IOP elevation	Higher, as multiple loops may increase iris manipulation	Higher risk of inflammation, especially if knots are too tight	Lower risk, but requires skill to avoid over-tightening	Lower risk of distortion, but improper tensioning may lead to pupil shape irregularities	Possible mild ovalization, but good for large pupil defects
Surgical Time	Shorter, as more iridodialysis is closed at once	Moderate, as multiple loops must be created	Moderate to long, depending on knot placement	Faster than McCannel, due to closed-chamber technique	Short, as it requires a single suture pass	Longer, as it requires even tension control
Learning Curve	Easier for surgeons, particularly for larger defects	Short learning curve, but requires more suture work	Moderate, due to external knot tying	More complex, requires expertise in sliding knots	Shorter learning curve, good for less experienced surgeons	Steep learning curve, requires skill in suture tensioning
Approach	Uses a precut iris retractor segment as structural support	Uses a continuous looping suture technique similar to a sewing machine	Uses externalized sutures tied outside the eye and slid into the anterior chamber	Uses a closed-chamber sliding knot technique	Uses a self-locking, knotless suture in a single pass	Uses a continuous circumferential suture to restore a round pupil
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Best for	Large iridodialysis (>90°) needing minimal manipulation	Moderate defects (60°-120°) with cost-effectiveness	General iris repairs, pupilloplasty, and iridodialysis	Small to medium-sized iris defects, pupil adjustments	Minimally invasive iris repair, sectoral pupilloplasty	Severe traumatic mydriasis, pupil size correction

limitations. Future studies with larger patient cohorts and long-term follow-ups are warranted to further refine surgical strategies and assess functional outcomes in different patient populations.

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