

Iris Complications and Management in Cataract Surgery



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Serious Complications of the Iris During Cataract Surgery

Direct injuries to the iris such as phaco bites, hemorrhage, iris touch, and iris prolapse lead to significant problems with prolonged irritation, iris transillumination defects, and irreparable iris sphincter injury, resulting in unfavorable visual and cosmetic results such as de-rounded or mydriatic pupils. Conversely, a narrow pupil is a common cause of a complicating course of cataract surgery. Several pupil dilation strategies are described below. It is crucial to distinguish between a narrow, rigid pupil and a narrow, atonic pupil, as the timing and nature of the problems, as well as their management, are different.

Memo

The simplicity of a cataract operation depends critically on the size of the pupil and the rigidity of the iris

The Narrow, Rigid Pupil

A narrow, rigid pupil affects the entire surgical process. This type of pupil problem can arise from PEX, diabetes, uveitis, injuries, or glaucoma medication. Posterior synechiae or a fibrosis ring at the pupillary margin are common. With a rigid pupil

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size of less than 3–4 mm, depending on the experience of the surgeon, all steps of the surgery are difficult—from capsulorhexis to nuclear fragmentation to intraocular lens implantation. Therefore, a pupil dilation strategy is needed in these cases.

As early as the preoperative stage, maximum drug-induced mydriasis should be ensured. Intraoperative application of epinephrine (0.3 ml, 1:1000) intracamerally [11] and in the irrigation solution (0.5 ml of 1:1000 epinephrine and 500 ml BSS) have been shown to be effective [8]. The second step is viscodilation, in most cases, a simple deepening of the anterior chamber with a cohesive viscoelastic results in pupil dilation sufficient for capsulorhexis.

Surgical Management of Narrow, Rigid Pupils

Before the pupil is mechanically dilated, the presence of synechiae or a fibrosis ring must first be excluded. Loosening of synechiae can be achieved with a push–pull hook, but care must be taken not to overstretch the iris sphincter. It is not uncommon to find a fine fibrosis ring at the pupillary rim, typically in uveitis eyes, and especially in JIA-associated uveitis in children [12]. This ring must not be pulled off under any circumstances; doing so would injure the thin iris sphincter muscle (Videos 1 and 2). Instead, segmentation is performed with approx. 12–16 radial incisions (e.g., with 23 g vitreous scissors; better: curved diabetic scissors). The incisions must not injure the iris sphincter (see Fig. 1). More extensive mechanical pupil dilation strategies are ambivalent because all mechanical aids overstretch the iris sphincter and leave permanent damage.

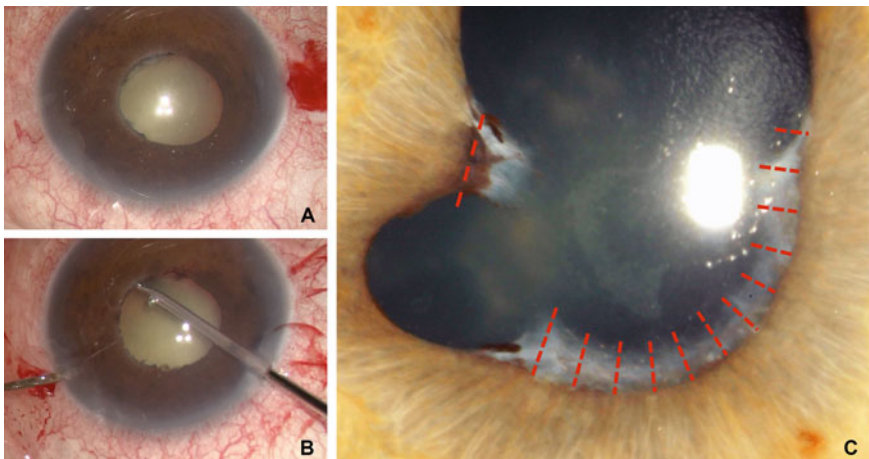
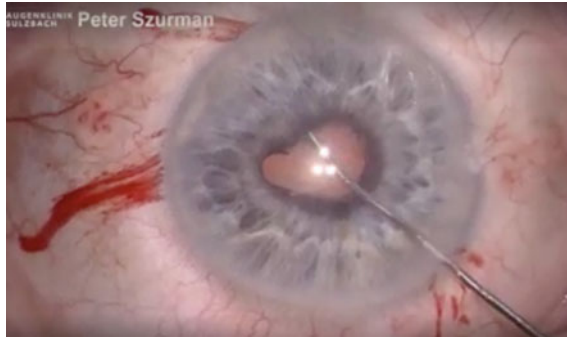


Fig. 1 Segmentation of fibrosis ring in uveitis. **A** Fibrotic ring **B** Radial incisions **C** Where incisions should be placed



Video 1 Segmentation of fibrosis ring in uveitis (► <https://doi.org/10.1007/000-8dm>)



Video 2 Removal of a pupillary membrane in uveitis (► <https://doi.org/10.1007/000-8dk>)

Iris stretching is particularly critical: two push–pull hooks are hooked over opposite paracenteses in the pupil margin and pulled against each other. The slightly dilated pupil is then atonic and complicates rather than facilitates the further course of surgery [7].

Iris retractors have a similar effect. For this purpose, four retractors are inserted via paracentesis, hooked into the pupil margin, and pulled outwards (Video 3). This results in a quadrangular dilated pupil. Aside from the permanent damage caused by sphincter tears (see Fig. 2), there is another disadvantage: iris retractors not only pull the pupil outwards but also pull the entire iris diaphragm upwards, which promotes prolapse of the iris base [13].

Pupil expanders such as the Malyugin ring are comparatively gentler. They lead to a more rounded pupil configuration and keep the iris diaphragm at the natural level (see Video 4). They can be easily implanted via the tunnel incision and explanted in the same manner (see Fig. 3). Postoperatively, an atonic pupil is rare, but microsphincter tears can still lead to permanent atony [9].



Video 3 Iris retractors with a narrow pupil (► <https://doi.org/10.1007/000-8dj>)

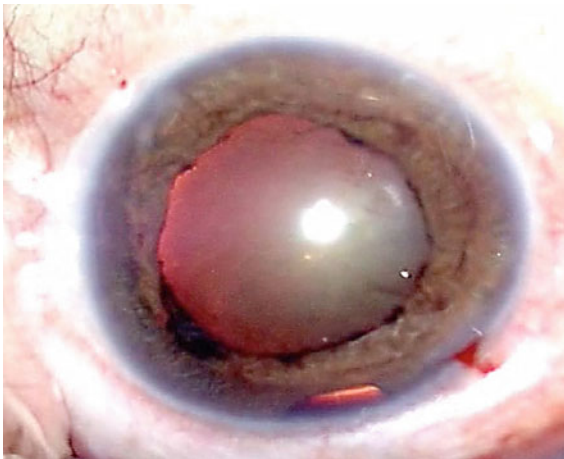
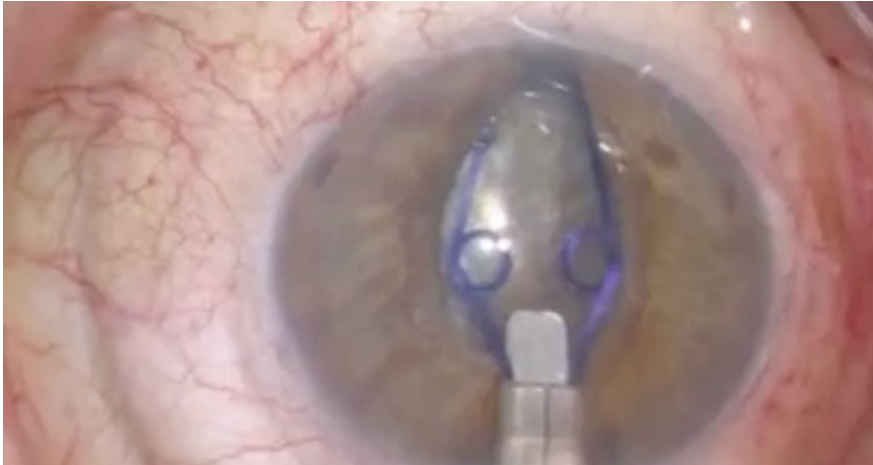


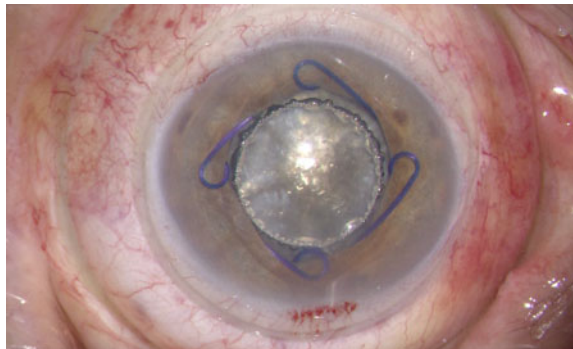
Fig. 2 Significant de-rounding after removal of iris retractors with permanent damage to the iris sphincter.

Therefore, experienced surgeons will avoid mechanical pupil dilation whenever possible and perform the surgery gently with a narrow or moderately dilated pupil. After intracamerally injecting epinephrine and subsequent viscodilation, often combined with various soft-shell techniques, a pupil width of 3.5-4 mm is almost always achieved, which is sufficient. It is then crucial that the capsulorhexis is created with a normal size. For this purpose, the capsulorhexis is guided under the iris, which is easier with a needle than with forceps (see Fig. 4). Phacoemulsification is performed in the capsular bag using a chop technique, which reduces the risk of iris aspiration.



Video 4 Malyugin pupil expander in the case of a narrow pupil (► <https://doi.org/10.1007/000-8dn>)

Fig. 3 Malyugin pupil expander in femto-assisted cataract surgery.



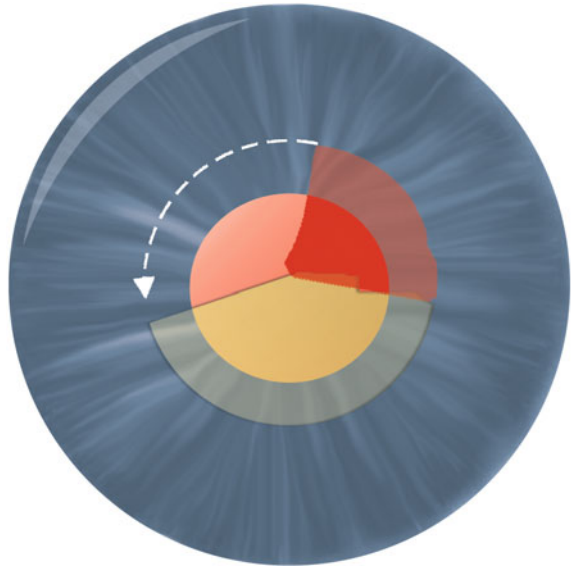
Author's recommendation

Mechanical pupil expanders can be helpful in selected cases. However, foregoing their use and performing the surgery when the pupil is not ideally dilated is the only way to spare the iris sphincter muscle.

The Narrow, Atonic Pupil in IFIS

Performing surgery on narrow, atonic pupils is entirely different, both with respect to the causative pathomechanism and the nature of the intraoperative problems. This type of pupil occurs mainly in IFIS, which was first described in 2005 in the context of tamsulosin [3]. Other drugs have since been reported to have similar

Fig. 4 Scheme of capsulorhexis underneath the iris without pupil expander with miotic pupil.



effects, but to a lesser extent. In addition to poor preoperative pupillary dilation, IFIS has a triad of typical intraoperative pathologies:

- (1) Atonic, floppy iris
- (2) Iris prolapse in tunnel incision and paracenteses
- (3) Progressive intraoperative miosis

The severity of IFIS is variable, with only 10% of all tamsulosin patients showing no IFIS signs at all, while half show a severe manifestation. Large studies show a twofold increase in the rate of severe postoperative complications [2]. Typically, the pupil and iris appear reasonably wide or stable at the beginning of surgery, but become increasingly atonic and floppy as the surgery progresses, therefore, most complications occur later in the surgery.

This slow onset and then markedly escalating course illustrates well why prevention is more important than management in IFIS. With the appropriate measures and preoperative identification of patients at risk, we can often prevent the most severe course and the complications that follow.

A patient's history should not only be screened for tamsulosin but also for other drugs with similar effects. It should be considered that women are increasingly treated with tamsulosin for urinary tract problems [5]. The most important prognostic warning sign for a severe course is poor preoperative mydriasis, while mild and moderate degrees of severity usually show sufficient mydriasis at the beginning and progressive miosis only during the course of surgery. Unfortunately, studies have shown that preoperative discontinuation of tamsulosin is ineffective [6].

Surgical Management of IFIS

To date, there is no proven protocol for preventing IFIS. However, several measures can significantly reduce the risk. Preoperatively, maximum dilatation should be attempted. In some studies, atropine has also been shown to be additively effective [10]. Even if the pupil does not dilate, this form of prophylaxis stiffens the iris tissue, reduces fluctuation, and decreases the risk for progressive intraoperative miosis later in the surgical procedure.

The same effect is achieved by the intracameral injection of alpha agonists such as phenylephrine or epinephrine. We use 1:000 epinephrine along with the intracameral local anesthetic lidocaine, which has a supportive effect. Mydrane® (tropicamide 0.02% + phenylephrine 0.31% + lidocaine 1%, Thea Pharma) is a new on-label drug that also achieves this effect. In addition, adding epinephrine to the irrigation fluid has a beneficial effect [4], for dosage details, see above.

The onset of surgery is mostly free of complications. The pupil is usually moderately dilated, and in the viscoelastic-filled anterior chamber the atonic iris tissue is unproblematic. This time must be used for the largest possible capsulorhexis, which is pulled under the iris (see Fig. 4).

Here, it is important to understand the mechanism of how both iris flaccidity and miosis develop during surgery. The crucial factor is the irritation of the iris, which continuously increases during the course of the surgery. Two mechanisms are causative:

- One mechanism is continuous fluid convection, which irritates the iris. Therefore, it is crucial to keep irrigation low, with plenty of occlusion and little suction; a phaco chop requires less irrigation than a groove technique. In particular, the tunnel incision should be smaller than usual to completely seal the phaco tip, at the potential cost of mild corneal burn. Also, the paracenteses should be created flatter and more corneal than usual in order to make iris prolapse more difficult.
- Second, any contact with the iris must be prevented. For this very reason, mechanical pupil dilation strategies are largely contraindicated. In particular, iris stretching provokes iris irritation and is more likely to result in reactive miosis rather than dilation. Similarly, iris retractors that additionally pull the iris diaphragm upwards promote prolapse of the iris base and make iris contact by the phaco tip or bimanual I/A instruments more likely.

Only pupil expanders such as the Malyugin ring are still popular in IFIS surgery, but their beneficial effect is small because the iris stimulus promotes the fluctuation of the peripheral iris. In other words, a Malyugin ring does not prevent prolapse of the iris base, but it does prevent complete iris prolapse.

The reduction of flow parameters is an important factor in preventing iris damage. When the pupil is narrow, the iris tissue is closer to the zone of high fluid flow. Therefore, the phaco tip and I/A instruments should be held in a central position with minimal movement to prevent iris damage. Many surgeons perform

the core fragmentation completely inside the capsular bag because this allows the fluidic flow to be localized inside the capsular bag. Other surgeons argue the converse and advocate an anterior chamber phaco because the fluid flow pushes the iris backwards. The tri-soft-shell technique may have some value here in stabilizing the iris diaphragm and limiting the flow dynamics [1].

Author's recommendation

In IFIS surgery, the maximum possible mechanical pupil dilation is not the decisive factor. Much more important is an iris-preserving surgical procedure with little fluid convection; tight, anteriorly created incisions; and motionless nucleus processing with controlled, centrally held instruments without iris contact (Video 5).



Video 5 Surgery for IFIS without pupil expander (► <https://doi.org/10.1007/000-8dp>)

Iris Prolapse

Iris prolapse is a serious complication that cataract surgeons seek to avoid. Causes may include tunnel incisions that are too wide and too short, or vitreous pressure, but iris prolapse most commonly occurs in the setting of IFIS, typically later in the course of cataract surgery. Recurrent prolapse, as is typical with IFIS, results in serious, permanent damage with iris transillumination, pupil de-rounding, and atony. Therefore, the above-mentioned prevention strategies are of paramount importance. However, once iris prolapse has occurred, rapid and consistent action is required.

The immediate generation of hypotension is crucial for management: switching off the infusion, draining fluid by applying pressure to the paracenteses, and flattening the anterior chamber. Only then may the phaco tip be removed and the iris repositioned. Often the iris falls back on its own as a result of the hypotony; if not, the iris should not be actively pushed back. This can be done more gently by carefully tapping on the tunnel lip or carefully pushing it back with a viscoelastic. Only in the case of failure should the iris be rubbed back from the inside.

With IFIS, the phaco should not be continued in the same manner afterwards. The hope for a one-off event is usually in vain. In IFIS, an iris prolapse will occur progressively with increasing frequency and extension, as the prolapse-related iris irritation further intensifies the atony. Supporting measures for the iris base, such as placing a viscoelastic depot under the tunnel or iris retractors next to the tunnel, are also not sustainable. The best solution is a consistent "new start" by suturing the tunnel incision and creating a new tunnel incision at a different site—one that is more corneal, longer, and tighter. Repeated intracameral administration of epinephrine and lidocaine is helpful, but it does not solve the problem at this stage. The subsequent implantation of a pupil expander is also hardly helpful here, but in severe cases it can at least protect the pupillary margin. The conscientious control of the fluid dynamics in the further course with low infusion pressure is more important, along with attentiveness towards the direction of the irrigation jet and rapid completion of the surgery.

Memo

Careful attention to fluid dynamics can prevent this frustrating complication.

Direct Injuries to the Iris

A mechanical injury to the iris typically occurs as a result of narrow pupils with or without IFIS and also inattention. Touching or aspiration of the iris into a handpiece without ultrasound energy usually causes minor iris defects, and significantly greater damage is done when aspirating with ultrasound activation. In these cases, immediate hypotension helps, and only then, if necessary, aspiration with a second instrument. Possible bleeding usually stops when the anterior chamber pressure is increased and only rarely needs to be coagulated.

In the damaged area, usually only the frayed iris fibrils remain, which repeatedly leads to further aspiration. In these cases, a pupil expander such as the Malyugin ring is useful.

Author's recommendation

If, in rare cases, an extensive iris defect or tissue loss occurs, a two-step approach to iris reconstruction is preferable. In simultaneous procedures, the irritation caused by iris injury and iris reconstruction potentiate and reinforce each other (see Chap. 57).

Conclusion

Cataract surgery for narrow and especially atonic pupils is challenging. Most surgical maneuvers for pupil dilation are not reliable and cause microtears in the iris sphincter. Therefore, primary prevention is by far the preferable measure and usually prevents a severe course. As always in iris surgery, the gentlest route is usually the best.

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