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TECHNIQUE

No ring approach technique for Nd:YAG capsulotomy in pinhole intraocular lenses: mask-sparing strategy to prevent occluder ring damage

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Posterior capsule opacification (PCO) is the most common late complication after cataract surgery, with incidence rates influenced by intraocular lens (IOL) material and design. Small-aperture IOLs such as the IC-8 Apthera incorporate a central carbon-black mask that provides extended depth of focus but is highly susceptible to Nd:YAG laser energy. Bench experiments demonstrate that identical pulse settings cause catastrophic mask fragmentation with volumetric material loss, whereas the hydrophobic acrylic periphery shows only microscopic pits. Clinical cases confirm that inadvertent mask hits may induce dysphotopsia and necessitate IOL exchange. The "no ring approach" (NORA) strategy is introduced to prevent such outcomes by confining laser application either within the 1.36 mm central aperture or in the clear peripheral optic while strictly avoiding the 3.23 mm carbon-black mask. Practical recommendations include wide dilation, low initial energy, posterior offset, and careful alignment. Adoption of the NORA technique preserves the optical benefits of pinhole IOLs while enabling safe restoration of vision after PCO.

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Nd:YAG laser posterior capsulotomy reliably restores vision in the event of posterior capsule opacification (PCO). Inadvertent intraocular lens (IOL) damage ("YAG pits"), however, can degrade optical quality. Small-aperture (pinhole) IOLs incorporate a carbon-black polyvinylidene fluoride (PVDF) mask to achieve extended depth of focus that may be extremely vulnerable to misfocused laser pulses. Bench work and clinical reports demonstrate that, at identical energy settings, laser hits to the black mask can cause catastrophic fragmentation and volumetric loss orders of magnitude greater than defects in clear hydrophobic acrylic material. This Viewpoint translates evidence into a practical, safety-first approach for routine care. We propose the "NORA technique" (no ring approach technique): confine Nd:YAG shots either to the central aperture or to the peripheral clear optic while strictly avoiding the carbon-black ring. This aims to maintain the optical benefits of the pinhole design, minimize glare and straylight, and reduce the risk of lens exchange. Because even a single pit in the mask may have devastating and irreversible consequences, shots to the black mask must be avoided under all circumstances.

PCO remains the most common late complication after phacoemulsification with posterior chamber IOL implantation. Large real-world series report cumulative Nd:YAG posterior capsulotomy incidences around 2.0% at 1 year, 9.5% at 3 years, and approximately 12.0% at 5 years, with material-dependent and design-dependent variation (hydrophilic acrylic > hydrophobic acrylic).[1] Hydrophobic acrylic optics consistently show lower PCO and Nd:YAG capsulotomy rates than hydrophilic designs in randomized trials and meta-analyses, and some specific hydrophobic platforms exhibit ~5% capsulotomy at 3 years compared with 21% to 31% for alternative materials.[2,3] Surgeons should therefore anticipate PCO in recipients of small-aperture IOLs and plan capsulotomy accordingly.

Recent laboratory work purposefully created Nd:YAG defects using identical energy levels on the clear hydrophobic acrylic periphery and on the carbon-black PVDF mask of a small-aperture IOL. Microcomputed tomography showed that mask hits generated massive material loss (missing volume ~0.266 mm^3, ≈1.6% of total IOL volume), detachment of fragments, and through-cuts, whereas same-

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energy shots confined to the clear acrylic produced only microscopic pits comparable with those seen in conventional hydrophobic acrylic lenses.[4] Complementary case evidence describes "carbon bursts" within the mask after capsulotomy that were associated with visual phenomena and ultimately necessitated IOL exchange.[5] Independent bench studies have quantified the optical consequences of laser capsulotomy defects—reduced modulation transfer, decreased spectral transmittance, and Huygens-type secondary light sources that elevate background illumination—providing a mechanistic rationale for meticulous shot placement in these eyes.[6] Collectively, these data underscore a single clinical imperative: do the capsulotomy while never touching the ring.

SURGICAL TECHNIQUE

Before scheduling the capsulotomy, it is important to confirm the IOL model and presence of a small-aperture design. The IC-8 Apthera (Bausch & Lomb, Inc.) features a 3.23 mm diameter carbon-black PVDF mask with a central 1.36 mm aperture embedded in a 6.0 mm hydrophobic acrylic optic, a geometry that determines safe and unsafe zones. Discuss with the patient the specific risks of lens damage and the potential need for lens exchange if the mask is hit. Use a laser capsulotomy contact lens to stabilize the eye, improve focus control, and reduce delivered energy.

It is prudent to use the lowest effective pulse energy and a posterior focus offset to keep the photodisruptive plasma behind the IOL. Initiate with single-pulse energies of 1.2 to 1.8 mJ, titrating conservatively as needed (often within 1.6 to 2.0 mJ for denser PCO). Establish a posterior offset of 100 to 250 µm, maintain precise coaxial alignment, and adjust chin rest and beam centration to steer energy away from the mask edge. Because mask absorbance reduces the ablation threshold, even routine energies can precipitate mask fragmentation if directly hit. Accidental hits can lead not only to cosmetic damage but also to functional deterioration, fragmentation with intralenticular particles, dysphotopsias, and potential lens explantation. Slow, deliberate shot placement in a quiet room with optimal patient cooperation seems essential.

Two mask-sparing placement strategies are possible. First, an "inside-the-aperture" approach confines shots to the 1.36 mm opening, focusing posterior to the capsule and enlarging only until the opening clears the optical pupil. Because this is the most critical portion of the optic, even a single pit here may impair image quality and must be avoided. Alternatively, an "outside-the-mask" approach places shots in the clear optic at a conservative standoff from the mask: create a circular opening either within the clear optic or approximately 1.0 mm outside the border of the mask (case-based recommendations) dilating the pupil widely to ensure visibility.[5] In practical terms, the IC-8 geometry (3.23 mm mask diameter) plus a ~1 mm safety

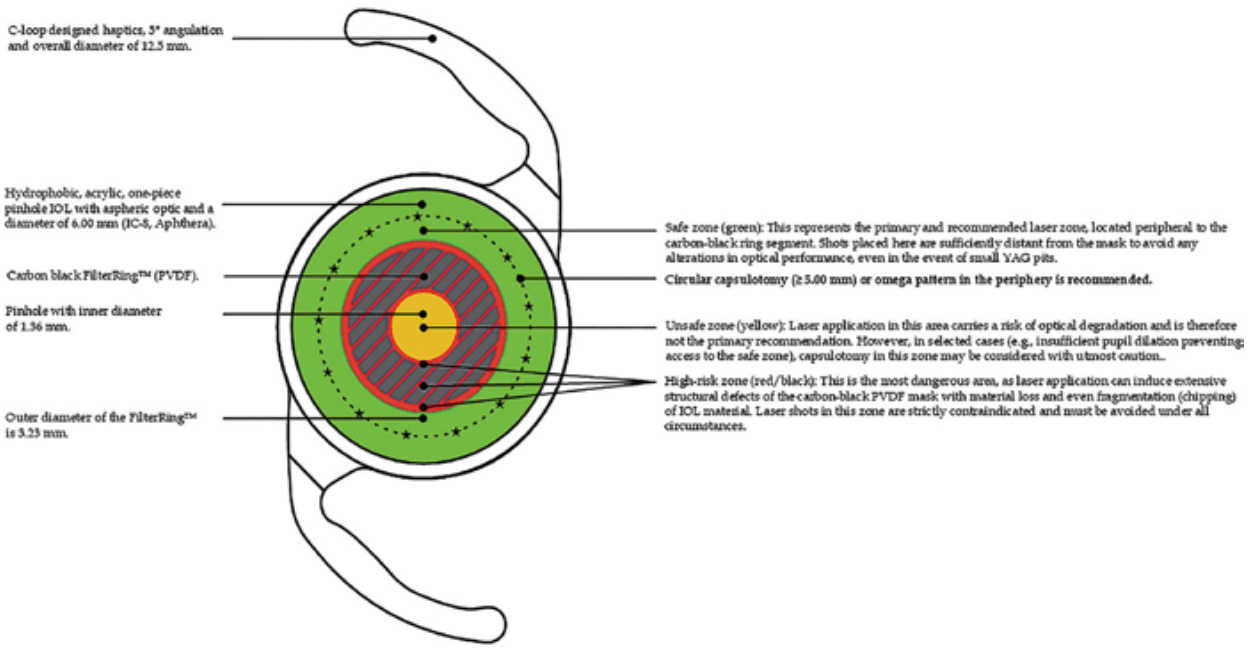

Figure 1. Schematic of the IC-8 Apthera showing safe (green) and unsafe zones: 6.0 mm hydrophobic acrylic optic with 3.23 mm carbon-black polyvinylidene fluoride mask and 1.36 mm central aperture. The high-risk zone is the mask itself; the unsafe zone is the central aperture (risk of visually significant pits); the safest zone is the peripheral clear optic. A circular capsulotomy ≥5.0 mm is advised when using the outside-the-mask approach.

margin around the ring yields a capsulotomy on the order of ≥5.0 mm when the outside-the-mask approach is chosen; both strategies prioritize compact openings for optics and enlarge only if clinically indicated.[7] Throughout, confirm focus on the posterior capsule (and not within the IOL) before each shot (see Figure 1 for schematic illustration of safe and unsafe laser zones).

Postprocedure, measure IOP within 30 to 60 minutes if warranted and monitor for rare but serious complications such as cystoid macular edema, retinal detachment, or secondary glaucoma. If inadvertent mask hits are suspected—for example, visible craters, dark intralenticular changes, or new dysphotopsias—perform slitlamp photography and consider anterior segment optical coherence tomography. Persistent, visually significant phenomena, especially with intramask fragmentation, may require IOL exchange.

DISCUSSION

Why NORA? The NORA technique integrates epidemiology (PCO and capsulotomy remain expected events with material-dependent risk), bench evidence (mask hits cause macroscopic destruction), and optical performance data (laser defects reduce contrast and elevate straylight).[1–4,6] Prevention is the only effective strategy; no treatment can reverse black-ring injury once created. Adopting NORA offers a straightforward, reproducible way to preserve the optical integrity of these pinhole IOLs while safely delivering the benefits of Nd:YAG capsulotomy. Given that Nd:YAG capsulotomy is a routine procedure often performed outside the primary surgeon's practice, a standardized, easily teachable approach is particularly relevant. NORA translates material-specific risk into an actionable strategy, reducing the likelihood of irreversible lens damage and subsequent IOL exchange. Equally important is thorough preprocedural patient counseling. Clear instructions regarding fixation, the need to remain still, and the potential impact of sudden head or eye movements are essential because even brief loss of alignment may result in inadvertent laser application to the mask and irreversible optical damage.

This work has several limitations that should be acknowledged. First, the recommendations presented are primarily based on bench experiments, optical modeling, and published clinical case reports rather than prospective, controlled clinical trials. It is inherently difficult to obtain high-quality prospective data for rare but clinically significant complications because such events occur unpredictably and cannot be ethically or practically studied in a controlled fashion. Quantitative postoperative visual outcome data and long-term clinical validation of the NORA technique are therefore not available. As such, the proposed approach should be regarded as an evidence-informed, preventive strategy and clinical guideline to prevent complications.

Second, the applicability of the NORA technique is currently focused on the IC-8 Apthera small-aperture IOL. At present, this lens represents the only commercially available pinhole IOL because previously marketed alternatives are no longer available and other pinhole devices are limited to custom-made implants for specific indications. Nevertheless, from a materials science and optical standpoint, any acrylic IOL incorporating an opaque, carbon-based occluder is expected to exhibit similar vulnerability to Nd:YAG laser energy. Finally, this article does not aim to redefine indications for Nd:YAG capsulotomy or to compare different capsulotomy patterns in visual outcomes. Instead, it focuses specifically on risk prevention and patient safety in a unique IOL design with a narrow margin for error. Further prospective studies are warranted to quantify visual performance, patient-reported outcomes, and complication rates after mask-sparing Nd:YAG capsulotomy techniques.

Given the irreversible nature of carbon-mask injury, prevention through meticulous shot placement remains the only effective strategy when performing Nd:YAG capsulotomy in eyes with small-aperture IOLs.

WHAT WAS KNOWN

- Posterior capsule opacification is a common late complication after cataract surgery.
- Nd:YAG laser capsulotomy can damage IOLs, but conventional hydrophobic acrylic optics usually tolerate minor pits.
- For small-aperture IOLs, the effect of Nd:YAG energy on the carbon-black mask and strategies to avoid catastrophic damage were unclear.

WHAT THIS PAPER ADDS

- Bench and clinical evidence shows that even a single Nd:YAG hit on the mask causes major structural and optical damage.
- The NORA technique defines safe and unsafe laser zones and provides a practical, reproducible method for mask-sparing Nd:YAG capsulotomy in small-aperture IOLs.
- Adoption of this approach preserves the optical benefits of pinhole IOLs and reduces the risk of explantation.

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