The optimal size of a posterior capsulotomy

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ABSTRACT

The optimal posterior capsulotomy diameter should be equal to the normal pupillary diameter in dark conditions to avoid glare and other undesirable optical aberrations. We studied 14 patients whose average pupillary diameter following cataract surgery was approximately 3.9 mm in scotopic conditions.

Key Words: glare, optical aberrations, posterior capsulotomy, scotopic conditions

Performing posterior capsulotomies with the Nd:YAG laser has not only eliminated the chance of infection, but also given us more control over the size and position of the opening.[1,2,3] With such fine control, the clinician must be aware of the optical and mechanical factors determining the optimal size of the capsulotomy.

MATERIALS AND METHODS

Fourteen patients who had uncomplicated extracapsular cataract surgery with posterior chamber intraocular lens (IOL) implantation were selected. The patients ranged from one to five years postoperative. Patients with synechias or irregular pupils were not admitted to the study. Patients were not using eye medications or taking systemic medications that would alter pupil size. The pupil size was recorded under photopic and scotopic conditions and mean values and standard deviations calculated.

RESULTS

Table 1 shows that the average pupil size in phototopic conditions was 2.1 mm with a standard deviation of 0.3 mm. The mean pupil size in scotopic conditions was 3.9 mm with a standard deviation of 0.5 mm.

Table 1. Pseudophakic* pupil sizes in scotopic and photopic conditions.

		Pupil Size (mm)	
Number	Age	Scotopic	Photopic
1	67	4.0	2.5
2	82	3.5	1.5
3	85	4.3	2.6
4	64	4.0	2.0
5	85	4.0	2.6
6	62	3.8	2.1
7	50	4.5	2.0
8	80	4.0	2.4
9	38	4.5	2.0
10	68	3.5	2.3
11	86	3.6	2.1
12	87	2.8	1.8
13	51	4.0	2.0
14	40	4.5	2.0
Mean	67.5	3.9	2.1
Standard deviation	17.4	0.5	0.3

*All patients had Sinskey-style, modified, J-loop posterior chamber IOLs with 10-degree anterior angulation of the loops.

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DISCUSSION

Two categories of factors, optical and mechanical, influence the optimal size of a posterior capsulotomy. As will be discussed, optical considerations argue for large capsulotomies, whereas mechanical considerations argue for the smallest possible opening. The optimal size will be the best compromise between these opposing factors.

The optical considerations favoring a large capsulotomy stem from three optical problems that are present with small openings: diffraction, reduced image intensity, and glare.

The minimum theoretical size for a capsulotomy is 2.4 mm in diameter. A smaller opening will limit the visual acuity by diffraction, as is well known to the clinician who follows patients using miotics. Although diffraction begins to reduce the visual acuity at a pupil size of 2.4 mm, the visual acuity is not limited to less than 20/20 until the aperture is below 1.4 mm.[4]

Decreased image intensity occurs if the capsulotomy is smaller than the pupil. The pupil normally regulates the amount of light entering the eye and is the primary adjustment that allows the eye to adapt rapidly to different light levels. The macula has some adaptive capacity, but this mechanism is too slow to be of immediate benefit. If the capsulotomy is smaller than the pupil, reflex changes in pupil size will only regulate the amount of light passing through the unopened capsule. The pupil will not regulate the macular image intensity, which remains constant.

The third optical problem arguing for a large capsulotomy, and for a capsulotomy at least as large as the pupil, is glare. When the discission is smaller than the pupil, the light passing through the unopened part of the capsule will be scattered and create glare in proportion to the surface area within the pupil and its diffusing properties. If the discission were 50% of the area of the pupil and the capsule were a 100% diffuser, we would have 50% glare from a discission that only occupies 50% of the pupil area. Although the patient's visual acuity may be excellent when tested in the darkened examining lane, normal lighting will create glare and the patient's functional vision will be significantly less.[5] Thus, the capsulotomy opening should be at least the size of the largest physiologic opening of the pupil, i.e., the pupil in scotopic conditions.

The mechanical considerations arguing for the smallest possible capsulotomy are based on the barrier effect of the intact posterior capsule following extracapsular cataract surgery. The advantage of the smallest aperture is that it maintains more of the barrier effect. Although studies to prove that the discission size is proportional to the incidence of cystoid macular edema and retinal detachment are inconclusive,[6] making the discission no larger than necessary reduces the chance of vitreous prolapse, requires fewer laser applications, and reduces the duration of treatment. In addition, tension on the capsule and pressure from the vitreous often result in a progressive enlargement of the discission size following the initial procedure.

The major advantages, then, of the large discission are avoiding diffraction, allowing the pupil to regulate image intensity, and reducing glare. These advantages must be balanced against the mechanical factors arguing for the smallest possible capsulotomy. To minimize diffraction and glare, the discission size should be just large enough to exceed the patient's normal pupil size in dark conditions.

Because the pupil size in scotopic conditions varies greatly in each patient, it should be measured with a slitlamp and reticle for optimal results. Previous studies have shown that in postoperative cataract patients with a posterior chamber IOL, the pupil size varies from 2.0 mm in light conditions to 5.0 mm in the dark.[5,7] In our patients, the mean scotopic pupil size was 3.9 mm. Therefore, discission sizes should typically range between 3.9 mm and 5.0 mm, provided this does not make vitreous prolapse around the lens probable.

Occasionally, because of a decentered lens, opening the capsule to the size of the scotopic pupil will result in vitreous prolapse. Vitreous prolapse around the lens into the anterior chamber is a more serious complication than the glare from this part of the capsule, and therefore limits the size of the capsulotomy. Because the capsulotomy opening may increase after the discission, we recommend that the capsulotomy be no closer than 0.5 mm to the edge of the IOL.

Glare testing and interest in contrast sensitivity is becoming more important as a result of extracapsular cataract extraction. As the number of patients with intact capsules or small discissions increases, we will begin to see more patients complaining of glare and other optical abnormalities such as light streaks.[8] The only treatment for these complaints is to eliminate the source of the glare within the pupil, which means an aperture that exceeds the pupil size in scotopic conditions.

CONCLUSION

The optimal posterior capsulotomy should equal or exceed the diameter of the pupil in scotopic conditions and remain within the border of the IOL. The typical scotopic pupil diameter following extracapsular cataract extraction with a posterior chamber lens varies between 3.9 mm and 5.0 mm, but the actual discission must be individualized by measurement for each patient.

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