Capsulovitreotomy: A technique for intracapsular lens extraction in cats

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Successful intracapsular lens extraction has been performed in the cat. This animal has a strong hyaloideocapsular attachment, a flaccid sclera, and a zonule which is highly resistant to alpha-chymotrypsin. Because of these characteristics, intracapsular lens extraction in cats is not possible by conventional methods. Using osmotic agents, cryoextraction, and surgical microscopy, we have performed direct, sharp dissection of the zonule and the hyaloideocapsular attachment (zonulotomy and capsulovitreotomy) in 28 cat eyes. Complete intracapsular extraction without vitreous loss was accomplished in 24 of these, including the last 14 consecutive cases. When complications arose, they occurred during zonulotomy rather than capsulovitreotomy.

Key words: intracapsular lens extraction, cat, ligament of Wieger, capsule, vitreous, cryoextraction, microsurgery.

Intracapsular lens extraction in cats is impossible by conventional methods. Kelman has noted that attempts to remove the posterior capsule in some 80 cat eyes always caused rupture of the hyaloid face with loss of vitreous. In addition we have found that traditional intracapsular extraction of the whole lens in this species invariably caused a large vitreous loss.

For intracapsular lens extraction in the cat, we currently use sharp, microsurgical dissection to separate the anterior hyaloid face from the posterior lens capsule. This dissection permits reliable intracapsular extraction without demonstrable injury to the vitreous or the posterior segment.

Methods and materials

Animals, preoperative measures, and anesthesia. Operations were carried out in 28 eyes of 14 young cats weighing 1.5 to 2.5 kilograms. No preoperative medications were used. Animals were anesthetized with 30 mg. of sodium pentobarbital per kilogram of body weight administered intraperitoneally. When general anesthesia was achieved, a tracheostomy was performed, a tube was tied into the trachea, and a polyethylene catheter was placed in the femoral vein. Acetazolamide, 5 mg. per kilogram of body weight, was given intravenously, and 2 Gm. of mannitol was given intraperitoneally.
per kilogram of body weight was infused in a 20 per cent solution over a 30 minute period.

Preparatory surgical procedures. In some animals a fornix-based conjunctival flap was raised superiorly, and a scratch incision was made at the limbus in the 12 o'clock meridian. A 7-0 black silk appositional suture was placed across this incision, and the anterior chamber was entered \textit{ab externo} at 12 o'clock. In other animals a 3 mm. limbus-based conjunctival flap was dissected superiorly. A grooved incision was made at the posterior edge of the limbus from the 3 to the 9 o'clock meridian. A small step was created by a 0.5 mm. lamellar dissection into the cornea, and a 7-0 black silk suture was placed across the incision at 12 o'clock. The anterior chamber was entered \textit{ab externo} in this meridian to complete the creation of a corneal "half-lap incision."³

Subsequent procedures were exactly similar in all animals beginning with enlargement of the incision to 180 degrees with corneoscleral scissors. A solution containing alpha-chymotrypsin, 1 c.c. in a dilution of 1:5000, was instilled into the posterior chamber throughout 360 degrees, and a period varying from two to five minutes was permitted to elapse before the procedure was continued.

Technique of capsulovitreotomy. The iris was retracted in the 12 o'clock meridian, and an Amoils 1.5 mm. curved cataract cryoprobe was applied to the lens near the equator superiorly (Fig. 1, A). The lens surface was indented by pressure with the cryoprobe tip in order to increase the area of contact before activating the freezing cycle. After formation of a firm cryoadhesion to the lens, the superior equator of the lens was tipped slightly anteriorly by traction with the probe.

Despite the use of alpha-chymotrypsin, it

![Fig. 1, A-C. Capsulovitreotomy. A, Iris retraction with plastic retractor (r) and application of cryoprobe (c) to lens (le). Retraction reveals zonule and ciliary processes. Note that probe indents lens slightly before freezing in order to increase surface area of cryoadhesion. B, Zonulotomy or sharp dissection of zonule (z) with Desmarres sclerotome (s). The knife enters a "surgical plane" between the vitreous and the lens. C, Anteroinferior rotation of superior portion of lens continues exposure and dissection of the hyaloideocapsular attachment. As dissection is completed the lens is delivered, and the vitreous drops behind the pupil.](https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/932866/)
Capsulovitrectomy was frequently necessary to lyse the zonular fibers by sharp dissection; neither traction-torsion nor blunt dissection would complete zonular rupture. This sharp dissection (zonulotomy) was performed under high magnification with the operating microscope, using a disposable Desmarres sclerotome (Beaver blade No. 57) (Fig. 1, B). During zonulotomy, it was occasionally necessary to cut tips of ciliary processes which were adherent to the equator of the lens.

After completion of zonulotomy in the superior quadrants, it became possible to elevate and tip the lens slightly forward, exposing the superior portion of the hyaloidocapsular attachment (ligament of Wieger). To facilitate visualization of this area, the microscope was tilted so as to aim at the field at an acute angle. Support of the lens was maintained with the cryoprobe, and the Desmarres sclerotome was used to achieve sharp dissection of the capsulovitreous interface (Fig. 1, C). It was found that short smooth strokes of the blade led to separation of the lens from the vitreous face, leaving both structures intact; an apparent tissue plane between the lens and vitreous was entered in this fashion with surprising ease. The dissection was continued while gentle traction and rotation of the superior equator in an anteroinferior direction were maintained. Cap-

Fig. 2. Gross culotte of aphakic cat eye after intracapsular lens extraction by capsulovitrectomy. Note cut edge (arrows) of intact vitreous face (vf), attached retina, and absence of capsular remnants.

Fig. 3. A, Microscopic section of lens from cat eye shown in Fig. 2. Arrows indicate intact capsule (c), tip of ciliary process (cp), and cutting artifacts (a). (Periodic acid-Schiff; x10.) B, Section of vitreous face from same eye. Particular structures are pigment granules (pg) and occasional red blood cells (rbc). (Alcian blue; x450.)
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Fig. 4. Hyaloideocapsular attachment (HCA) in the cat. The vitreous (v) is suspended by its attachment to the posterior lens capsule while the lens (le) is held with a cryoprobe (c).

Fig. 5. Capsulovitrectomy. Iris retraction (r) and application of cryoprobe to lens; note that probe indents lens before freezing. (Cornea [c] is reflected for photography.)

Capsulovitrectomy and zonulotomy were completed inferiorly and, as the lens was delivered, the vitreous face receded posterior to the pupil in most instances. After application of the cryoprobe, the total time for the dissection varied between one and three minutes.

The corneoscleral section was closed by tying the 12 o'clock silk suture and by placing additional interrupted sutures across the incision. If vitreous remained in the anterior chamber, injection of air at this point invariably displaced the hyaloid face behind the pupil.

Gross examination of eyes and histopathologic studies. Every lens removed was inspected through the operating microscope for the presence of an intact lens capsule. After air injection and completion of corneal closure, eight eyes were enucleated and fixed in 2 per cent buffered glutaraldehyde. The globes were fixed for 24 hours and washed for 24 hours in running tap water. Each eye was opened with a razor blade and inspected under a dissecting microscope for the presence of lens capsule remnants and evi-
Fig. 8. Capsulovitrectomy: Rotation of lens to continue exposure and dissection of the hyaloideocapsular attachment with sclerome (s). Vitreous face (vf) remains within pupil.

dence of retinal detachment or retinal breaks. The eyes were then embedded in paraffin and sectioned. Sections were stained with hematoxylin and eosin, periodic acid-Schiff, and Alcian blue and were examined by light microscopy.

Results
In 24 lens extractions by capsulovitrectomy, the whole lens was removed, and the vitreous face was left intact; in two extractions, the lens capsule was ruptured; and in two, vitreous was lost. Each of the four operative complications occurred during the first several extractions in this investigation, and they accompanied our attempts at mechanical lysis of the zonule. The extractions in the last half of the series were all uncomplicated.

Each of the eight eyes examined histopathologically showed an intact vitreous face, no evidence of retained lens capsule, and no evidence of retinal breaks or retinal detachment. A representative example of one of the aphakic eyes with its intact, excised lens is shown in Figs. 2 and 3.

Discussion
The complications in four eyes of this series occurred because of incomplete zonulysis, not because of difficulty in separation of the vitreous from the lens. Whenever zonulysis or zonulotomy was successful, it was surprisingly easy, with microscopic control, to accomplish sharp dissection of the hyaloideocapsular attachment (Fig. 4). It was never possible to separate the vitreous from the lens with any form of blunt dissection or traction—instruments tried included a sable brush, a muscle hook, an iris spatula, and a zonule stripper. Photographic examples of the sharp dissection are shown in Figs. 5 through 9. Figs. 6 to 8 illustrate how the lens is kept near the pupil and is rotated rather than elevated in order to minimize traction on the vitreous.

The success of this dissection led to the investigation of two other species: limited studies of rabbits and young rhesus monkeys, however, revealed a marked variability in the strength of the hyaloideocapsular attachment. The cat was the only species in which a strong hyaloideocapsular attachment was a constant finding.

As shown in the present study, this anatomic characteristic does not necessarily prevent successful intracapsular lens extraction. Micorsurgical technique allows direct dissection of the attachment between the vitreous and the posterior lens capsule.
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REFERENCES

Erratum