Visual Results and Complications of Phacoemulsification with Intraocular Lens Implantation Performed by Ophthalmology Residents

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The authors retrospectively analyzed the visual outcome and incidence of complications of 181 consecutive cases of phacoemulsification performed by eight third-year ophthalmology residents. A posterior chamber intraocular lens was implanted in 179 of these eyes. Vitreous loss occurred in 5.5% of cases. The overall incidence of posterior capsule rupture was 9.9%; of the 18 posterior capsular ruptures, 72% were detected during cortical removal and 22% during nuclear emulsification. Postoperative follow-up for 177 eyes was at least 2 months, and 70% were followed for 6 months or longer. Final best corrected visual acuity of 20/40 or better was obtained in 92.6% of eyes. These results are comparable with previous reports of residents' experience in performing planned extracapsular cataract extraction. With appropriate training and faculty supervision, residents learning to perform phacoemulsification and intraocular lens implantation can achieve acceptable results. *Ophthalmology 1992; 99:448–452*

Recent survey data indicate that phacoemulsification is rapidly increasing in popularity among ophthalmic surgeons.[1] Numerous studies have documented the results of residents performing extracapsular cataract surgery and of surgeons-in-practice converting to phacoemulsification; however, to our knowledge, a study of results of residents' conversion to phacoemulsification and posterior chamber lens implantation has not been published. Since 1989, phacoemulsification has been the primary mode of cataract extraction used by third-year residents at Cullen Eye Institute. In this study, we report the results of eight consecutive third-year residents' initial experiences with phacoemulsification with intraocular lens (IOL) implantation. Our purpose is to examine the visual results, to analyze the complications encountered with special attention to rates of posterior capsular rupture and of vitreous loss, and to identify problem areas in this stage of resident education.

Materials and Methods

We reviewed the records of all consecutive cases of attempted phacoemulsification with IOL implantation performed by eight third-year residents at the Houston Veteran Affairs Medical Center from July 20, 1989 through September 24, 1990; this study comprises 181 eyes. Before performing phacoemulsification, each resident had performed 30 to 50 extracapsular cataract extraction (ECCE) procedures as primary surgeon. Patients with advanced nuclear sclerosis, subluxated lenses, poorly dilatable pupils (less than 5 mm), and extensive endothelial guttata or low endothelial cell counts underwent planned extracapsular extraction and were excluded from our study.

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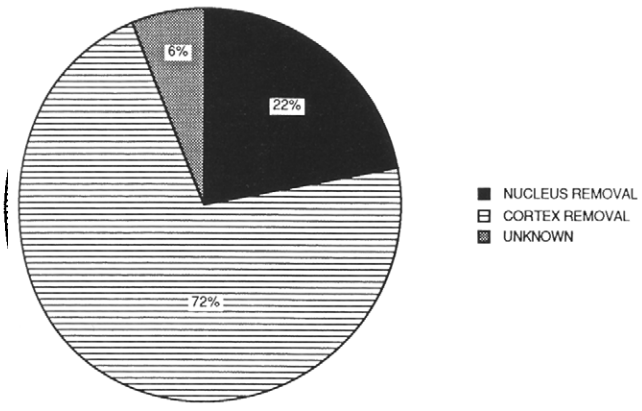

Figure 1. Pie chart illustrates stages of surgery in which posterior capsular ruptures were detected.

After providing informed consent, the patients received anesthesia/akinesia via a retrobulbar and either a Van Lint or modified O'Brien facial nerve block. The anesthetic agent used was a 1:1 mixture of 2% lidocaine and 0.5% bupivacaine, to which hyaluronidase had been added. The Honan balloon, manual compression, or both, were used to reduce the intraocular pressure.

The usual procedure (with some individual variations) consisted of the following:

1. Superior and inferior rectus bridle sutures were inserted.
2. A superior, fornix-based conjunctival peritomy was performed.
3. The limbal and anterior scleral vessels were cauterized.
4. A limbal or scleral-flap incision was created.
5. The anterior chamber was entered at the 2-o'clock position with a microsurgical steel knife and then entered again in the incision with a 3-mm keratome.
6. The anterior chamber was filled with 1% sodium hyaluronate (Healon, Kabi Pharmacia Ophthalmics, Monrovia, CA).
7. Anterior continuous circular capsulorhexis was performed, using a bent 25-gauge needle and Kraff-Utrata forceps.
8. Multilamellar hydrodissection was performed to hydrodissect the nucleus and the cortex.[2]
9. The nucleus was emulsified in the capsular bag using either the saucerization[3] or nucleus fracture (in situ fracture)[4] techniques.
10. The cortex was aspirated with an automated irrigation–aspiration unit.
11. Sodium hyaluronate was injected to deepen the anterior chamber and to open the capsular bag, the wound was enlarged with a microsurgical steel knife, and a 6- or 7-mm optic posterior chamber lens was implanted in the capsular bag.
12. The incision was closed using interrupted 10–0 nylon sutures.
13. Antibiotics were injected subconjunctivally, and the eye was tightly patched.

In cases of inadvertent vitreous loss, an automated vitrectomy was performed through the limbal incision and through the rent in the posterior capsule. The intent was to remove all vitreous from the anterior chamber while preserving the remaining posterior capsule. The surgeon determined the site for lens placement based on remaining capsular support.

Results

Follow-up

In this 14-month period, phacoemulsification and IOL implantation were performed on 181 eyes. Mean postoperative follow-up was 7.4 months (range, 1 week to 17 months). Four eyes had follow-up of only 1 week after surgery; we included them in the analysis of surgical complications but not in the analysis of visual acuity. Follow-up of the remaining 177 eyes was at least 2 months, and 70% of cases were followed for 6 months or longer.

Posterior Capsular Rupture and Vitreous Loss

Posterior capsular rupture occurred in 18 eyes (9.9%), and vitreous loss occurred in 10 eyes (5.5%). Posterior capsular rupture was detected most frequently during cortical aspiration (Fig 1); in 6% of the ruptures, the time of occurrence or detection of the rupture could not be determined from our review of the charts and operative reports.

Table 1. Intraocular Lens Implantation

	Number	Posterior Chamber		Anterior Chamber
		Capsular Bag	*Ciliary Sulcus*	
Overall group	181	170 (93.9%)	9 (5%)	2 (1.1%)
Intact posterior capsule	163	162 (99.4%)	1 (0.6%)	
Broken posterior capsule No vitreous loss	8	5 (62.5%)	2 (25%)	1 (12.5%)
Broken posterior capsule And vitreous loss	10	3 (30%)	6 (60%)	1 (10%)

Table 2. Postoperative Best-corrected Visual Acuities

	≥ 20/25	≥ 20/40	20/50–20/80	≤ 20/100
Overall Group (n = 177)	132 (74.6%)	164 (92.6%)	12 (6.8%)	1 (0.6%)
Intact Posterior Capsule (n = 159)	120 (75.5%)	148 (93.0%)	11 (7.0%)	0
Broken Posterior Capsule				
Without vitreous loss (n = 8)	6 (75.0%)	7 (87.5%)	1 (12.5%)	0
With vitreous loss (n = 10)	6 (60.0%)	9 (90.0%)	0	1 (10.0%)

Intraocular Lens Implantation

Intraocular lenses were implanted in all 181 eyes; posterior chamber lenses were implanted in all but two eyes, which received open-loop, four-point fixation anterior chamber lenses. In the overall group, 94% of lenses were inserted into the capsular bag (Table 1).

In the 8 eyes with posterior capsular rupture but no vitreous loss, 5 (62.5%) were implanted into the capsular bag, 2 (25%) into the ciliary sulcus, and 1 (12.5%) into the anterior chamber. In the 10 eyes with vitreous loss, 3 (30%) were implanted into the capsular bag, 6 (60%) into the ciliary sulcus, and 1 (10%) into the anterior chamber. In one of the ciliary sulcus lens implantations, posterior capsular support was deemed to be inadequate, and the surgeon therefore sutured the lens into the sulcus using a 10–0 polypropylene transscleral suture that was attached to each lens haptic.

Visual Acuity

In the overall group, best corrected visual acuity of 20/40 or better was attained in 92.6% of eyes and no eyes had visual acuity of 20/200 or worse. The final best corrected visual acuity of all eyes in each subgroup is listed in Table 2. All causes of postoperative visual acuity less than 20/40 are listed in Table 3. Of the 159 eyes without capsular rupture, 9 had pre-existing macular or retinal lesions that limited visual potential, and 6 of these 9 were not detected preoperatively. Five of the 9 eyes were limited to visual acuity less than 20/40; despite this, visual acuity was improved by at least 2 lines or more in 3 (60%) of these eyes.

In the 18 eyes with posterior capsular rupture, all but 2 (89%) achieved best-corrected visual acuity of 20/40 or better. Fifteen of these 18 eyes had follow-up longer than 6 months. The causes of this visual loss were cystoid macular edema (CME) and pre-existing subretinal neovascular membrane in one eye each.

Complications

A variety of postoperative complications occurred (Table 4). Clinical CME developed in 8 patients, and it was the primary cause of visual acuity less than 20/40. One eye with CME developed an epiretinal membrane and another developed a lamellar macular hole.

Table 3. Causes of Postoperative Visual Acuity Less Than 20/40

Cause	No.	Visual Acuity
Cystoid macular edema	5	20/60* (2), 20/80 (3)
Macular degeneration	5	20/50 (3), 20/60, 20/100†
Lamellar macular hole	1	20/50
Ischemic optic neuropathy	1	20/60
Corneo-scleral laceration with retinal detachment repair (preoperatively)	1	20/60

* One eye sustained posterior capsular rupture.

† This eye sustained vitreous loss.

Table 4. Complications after Phacoemulsification

Complications	No.*
Cystoid macular edema	8 (4.5%)
Persistent CME	5 (2.8%)
Unsuspected macular lesions	6 (3.4%)
Superior corneal edema (persistent)	4 (2.3%)
IOL decentration (> 1 mm)	2 (1.1%)
Retained cortical material (Anterior chamber)	2 (1.1%)
Retained cortical material (Vitreous)	1 (0.6%)
Transient hyphema	1 (0.6%)
Epiretinal membrane	1 (0.6%)
Ischemic optic neuropathy	1 (0.6%)
Lamellar macular hole	1 (0.6%)
Central corneal edema	0 (0%)
Retinal detachment	0 (0%)
Endophthalmitis	0 (0%)

* Total number of operated eyes is 181.

IOL = intraocular lens.

Discussion

Phacoemulsification is a technically more complex operation than planned ECCE. In our institution, second-year residents typically perform 20 to 40 planned ECCE cases before entering their third year of training. Late in their second year, the residents included in this series took a 1-day phacoemulsification lecture and laboratory course taught by our faculty, and phacoemulsification surgery was begun in the third year if supervising faculty believed that the surgeon was "ready" (i.e., had demonstrated sufficient surgical judgment and technical skills in previous cases of ECCE). For all but one resident surgeon, this occurred sometime in the first month of the third year.

Although there are two sites that provide the majority of resident surgical experience in our training program, in the course of this study the vast majority of phacoemulsification was performed at the VA Medical Center. The cases reported herein include the initial phacoemulsification operations performed by 7 of the 8 surgeons. Although we did not attempt to stratify cases according to their position in each resident's surgical experience, overall these cases were within the first 40 performed by each surgeon. We recognize that our series, like other resident studies, is limited by the variable and relatively short follow-up interval.

We believe that this series demonstrates that acceptable results are attainable when teaching phacoemulsification in a residency training program. In our series, posterior capsular rupture occurred in 9.9% of eyes, and vitreous loss occurred in 5.5% of eyes. In previous reports of surgeons-in-practice converting to phacoemulsification without IOL implantation, capsular rupture rates exceeded 10%.[5,6] We are unaware of any recent reports of surgeons-in-practice converting to phacoemulsification. In an early study of resident phacoemulsification surgery without IOL implantation, Coltier and Rose[7] reported a 14.2% incidence of vitreous loss. Emery et al[8] studied 50 cases of resident phacoemulsification without IOL implantation performed at our institution in 1978 and reported a posterior capsular rupture rate of 24% and a vitreous loss rate of 8%.

Our incidences of posterior capsular rupture and vitreous loss also are acceptable when compared with results reported in three studies of residents beginning planned ECCE with or without IOL implantation. Browning and Cobo[9] reported a 17% incidence of posterior capsular rupture and a 9% incidence of vitreous loss in the first 25 cases of planned ECCE performed by residents. Pearson et al[10] reported an incidence of vitreous loss of 6.8% in 936 planned ECCEs performed by 24 residents over 6 years; however, this incidence dropped to 3.2% over the last 3 years of the study (Table 5). Straatsma et al[11] reported the best results with the vitreous loss rate of 2.9% in 139 eyes that comprised the first 18 cases of planned ECCE performed by 8 senior residents.

The visual results achieved in our series are slightly superior to those reported in these three series, and the postoperative visual acuity of 20/40 or better in 92.6% of eyes exceeds the standard of 85% reported by Stark et al[12] that is used in the grid for premarket approval applications to the United States Food and Drug Administration (Table 5).

The outcome of the patients who experienced posterior capsular rupture also was encouraging. In all but three patients, posterior chamber lenses were directly implanted into either the capsular bag or ciliary sulcus. No problems with postoperative lens dislocation occurred, and the visual results were excellent (89% of patients with visual acuity greater than 20/40). We attribute this to liberal use of viscoelastic agents to identify and define anatomic spaces and meticulous vitreous clean-up without compromising posterior capsular support. However, we recognize that these patients are at greater risk for vision-threatening complications. The incidence of clinical CME was 16.7% in the posterior capsular rupture group, compared with 2.8% in those with intact posterior capsules. Furthermore, based on previous reports, we suspect that the patients with vitreous loss are at greater risk for developing postoperative retinal detachment,[13,14] although none occurred during the relatively short follow-up interval in our series.

In our series, posterior capsular rupture occurred most often during cortical aspiration (72%). This is in com-

Table 5. Results of Resident Cataract Surgery with or without IOL Implantation

Series	Number of Eyes	Method of Cataract Extraction	Vitreous Loss	Percent 20/40 or Better
Straatsma et al.[11]	144	ECCE	2.9%	88%
Browning and Cobo[9]	130	ECCE	9%	89%
Pearson et al.[10]	936	ECCE	6.8% (3.2%)*	NR
Cruz et al.†	181	Phacoemulsification	5.5%	93%

IOL = intraocular lens; ECCE = extracapsular cataract extraction; NR = not reported.

* (During last 3 years of study)

† Our study.

parison to the series reported by Osher and Cionni,[15] in which it occurred during nucleus removal in 40% of eyes and during cortical removal or posterior capsular vacuuming in 44% of eyes. This suggests that, for resident surgeons, the primary difficulty with phacoemulsification is not emulsifying the nucleus but performing cortical removal through a 3-mm incision. Perhaps additional training in automated irrigation/aspiration and emphasis on supplementary techniques to remove less accessible cortex (e.g., at the 12-o'clock position) could reduce intraoperative complications.

We believe that the good results achieved by these resident surgeons are attributable to numerous factors. Compared with previous reports, the surgeons in our study had the advantage of improved instrumentation, more advanced surgical techniques (e.g., capsulorhexis and in situ fracture), and enhanced surgical aids (such as viscoelastic agents). Compared with surgeons-in-practice, the residents had supervising faculty present in the operating room during the vast majority of cases and available at all times. For most cases, supervising faculty served as first surgical assistants. We recognize that teaching phacoemulsification with IOL implantation to residents introduces a second learning curve—one for planned ECCE and one for phacoemulsification—but the relatively low incidence of complications in our series is reassuring.

The visual outcome and incidence of complications in our series can serve as benchmarks for residents-in-training beginning and surgeons-in-practice converting to phacoemulsification. As teaching methods, instrumentation, and surgical techniques improve, we look forward to even better results in future comparable series.

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