

# Surgical outcome following breach rhexis

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**PURPOSE.** *Phacoemulsification cataract surgery is the gold standard for lens removal and continuous curvilinear capsulorhexis is one of the important first steps during the procedure. It is also one of the most difficult steps to master and so has a learning curve and capsulorhexis breach is therefore common among trainees. Once there is capsulorhexis breach, the surgeon could continue with the procedure or convert to extracapsular extraction, with each having its advantages and disadvantages. In our unit, the phacoemulsification procedure is usually continued with some modifications, and the results over a specified period are presented.*

*To report the incidence of breach rhexis during phacoemulsification over a specific period, deduce reasons for the breach, as well as the surgical outcome including other intraoperative and postoperative complications directly resulting from the capsular tear.*

*Interventional case series.*

**METHODS.** *All patients who developed breach rhexis during routine phacoemulsification had all information regarding the procedure entered into a predesigned ProForma. These ranged from the instruments used for the capsulorhexis to subsequent surgical modification to reduce risk of further complications to the final surgical outcome.*

**RESULTS.** *In the study period March 12, 2004, to March 30, 2005, the team carried out 358 phacoemulsifications, of which 20 (0.56%) had breach rhexis. The end of the breach was visible in 70% of cases and equatorial in the rest. None extended to the posterior capsule and so there was no vitreous loss in any of these cases. In most of the cases, the cause of the breach was attributed to inexperience or error of judgment (60%). However, modification of the surgery including the transfer of the procedure to a more experienced surgeon helped to reduce the rate of further complications. Eighty-five percent of the patients achieved a corrected visual acuity of 6/12 or better and those with worse vision had comorbidity.*

**CONCLUSIONS.** *In this study, the authors showed that, when properly managed, capsular breach during phacoemulsification has little or no effect on the final surgical outcome. (Eur J Ophthalmol 2007; 17: 565-70)*

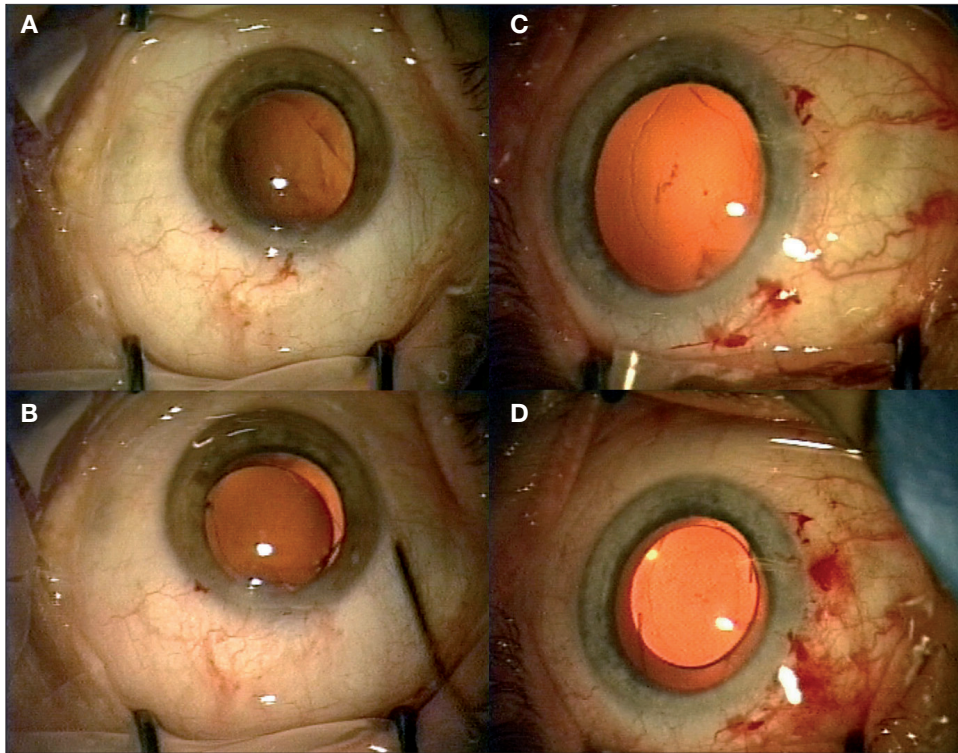
**KEY WORDS.** *Cataract, Phacoemulsification, Rhexis, Rip, Stress*

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## INTRODUCTION

Phacoemulsification cataract surgery is now the gold standard for lens removal (1). In order to complete the procedure safely, an intact continuous curvilinear capsulorhexis (CCC) is mandatory (2).

Phacoemulsification being a more closed surgical technique compared to the others (e.g., large incision extracapsular cataract extraction, intracapsular cataract extraction) has led to a considerable reduction in the incidence of vitreous loss (3). Underlying this is the advance made in anterior capsulotomy, i.e., CCC by Gimbel



**Fig. 1 - A, C)** Intraoperative photos of 2 patients showing the breach in the anterior capsulorrhexis. **B, D)** Postoperative photos of two patients showing the eye after intraocular lens implants.

and Neuhann (4). This technique provides advantages to the subsequent steps of surgery, which include stabilization of the nucleus in the capsular bag during divide and conquer and thereby minimizing endothelial damage, and its structural rigidity and integrity helping to maintain an intact capsular bag, which helps with intraocular lens (IOL) centration and haptic placement in the bag (3-5).

The technique of CCC is one of the most difficult steps of phacoemulsification surgery (personal communication with other colleagues) and has a learning curve, making it more likely that trainee surgeons tend to breach the capsulorrhexis more often. Also, due to the delicate nature of the lenticular capsule, tears can and do occur at any time during phacoemulsification but more commonly during grooving or segment removal due to the catching of the anterior capsule by the phaco probe.

Once the rhexis is breached, the surgical options include, among others, conversion to extracapsular cataract extraction (requiring extension of the section and suturing with potential complications such as induced astigmatism, iris prolapse, and longer postoperative recovery time), or continuation of the phacoemulsification, with the benefit of small incision surgery, less postoperative astigmatism, and quicker postoperative recovery. These advantages of continuing with the phacoemulsification have

to be balanced against the possible risks of complications like extension of the capsulorrhexis resulting in a rent in the posterior capsule and also the possibility of dropped nucleus.

In our unit, the Consultant (S.A.) uses the latter option, i.e., continuing with phacoemulsification with some adjustments to the technique and phaco parameters and developing different strategies to complete each stage of the surgery safely and effectively.

In this report, we present our experience of the patients with cataract who while having phacoemulsification developed tears in the anterior capsulorrhexis. During the study period we also ascertained the following: 1) the incidence of capsular tear, 2) possible reasons for the tear, 3) the surgical technique subsequently adopted, 4) intraoperative complication, 5) choice of IOL implant, and 6) postoperative outcome.

## MATERIALS AND METHODS

All patients under the care of one consultant (S.A.) who developed a tear in the anterior capsulorrhexis during routine phacoemulsification between March 12, 2004, and March 30, 2005, were included in the study. Anesthesia

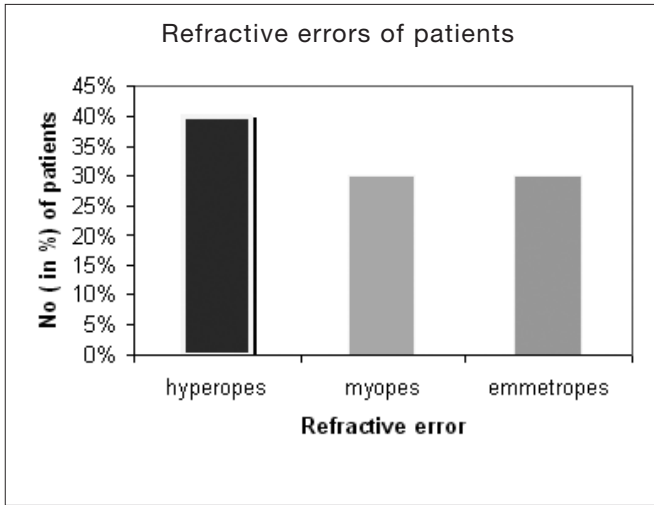


Fig. 2 - Number of patients in relation to the refractive errors.

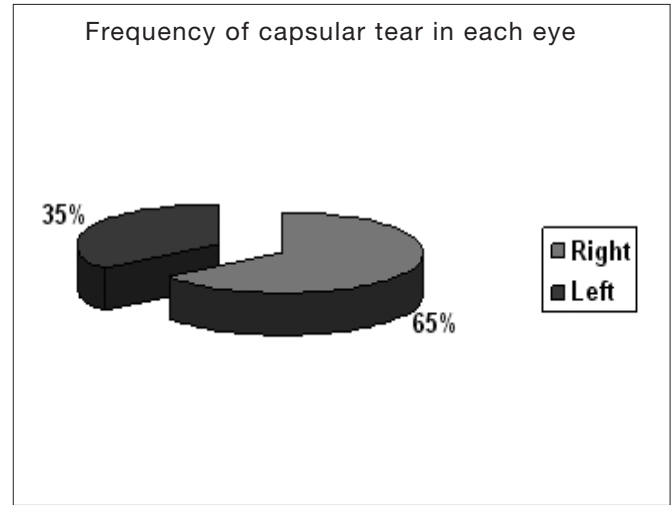


Fig. 3 - Capsular tear in each eye.

used during the study period included topical, sub-Tenon, peribulbar, and general, depending on the choice of the surgeon or the patient.

After a self sealing incision (corneal, scleral, or limbal) with the keratome (3.2 mm) and injection of sodium hyaluronate 1% or Coatel into the anterior chamber a CCC was performed. A bent 25-gauge needle on either a 1-mL or 5-mL syringe was used to make the first incision and then raise a flap before completing it with Utrata forceps or the needle. The aim was to make a 5 mm to 5.5 mm capsulorhexis.

After hydrodissection and ensuring that the nucleus was freely mobile the nucleus was removed by divide and conquer. An Alcon Legacy 2000 machine was used in all cases. Cortical matter was removed with a Simcoe canula connected to the Legacy 2000 for the irrigation and a 5 mL syringe for the aspiration, followed by IOL (Alcon AcrySof) implant in the bag after enlargement of the wound (Fig. 1 B, D). A pro forma was filled for every patient who developed a breach in the anterior capsulorrhexis (Fig. 1 A, C). This included the instruments used for the CCC, site of surgery, extent of capsular tear, and time of the capsular breach. Other information entered included probable cause of the capsular tear, whether the procedure was converted to extracapsular extraction or continued, any further complication, and position of IOL insertion. Finally, at 2 weeks after surgery, the corrected visual acuity was recorded and so was the presence or otherwise of any comorbidity or complication.

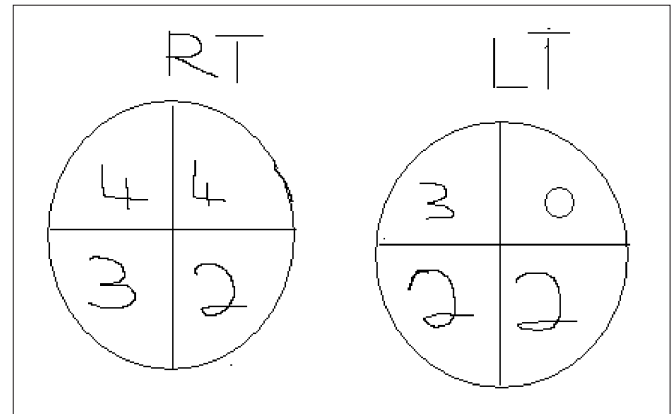


Fig. 4 - The number of capsular tears in each quadrant of each eye.

## RESULTS

During the study period we carried out 358 cataract operations and 20 (0.56%) had breach rhexis. In the study group the age ranged from 43 to 90 years (mean 65.5) and there were 12 (60%) females and 8 (40%) males. Forty percent were hyperopes, 30% myopes, and 30% emmetropes (Fig. 2). CCC was performed with the cystotome needle in 11 cases; both the Utrata forceps and needle were used in 8 cases and the Utrata forceps only in 1 case. Figure 3 shows the percentage occurrence of breach in right and left eyes.

The precise quadrant where the tear occurred and the number of such occurrences in each eye is as shown in

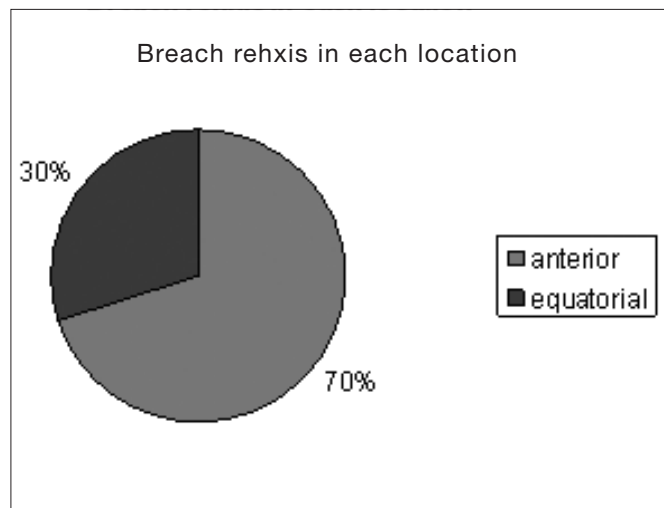


Fig. 5 - Locations of the tear.

Figure 4.

In 70% (14) of the cases, the tear edge was visible and was described as anteriorly located. For 6 cases (30%), the edges were invisible and as such were described as extending to the equator (Fig. 5).

It was during the capsulorhexis that the tear occurred in 60% (12) of the cases, while the event occurred during phacoemulsification in 20% (4) of the cases. The tear occurred in two cases each during irrigation and aspiration, and IOL implantation.

Error of judgment and inexperience accounted for 60% (12) of the cases. In some of these, the pupils became too small during the surgery, the anterior chamber was too shallow, or very hard nucleus was noted. In 15% (3), the cause was attributed to increased vitreous pressure, while in 2 cases (10%), it was thought to be due to increased eye movement at critical stages of the surgery, and a similar number for faulty focusing. The anterior capsule was too brittle in one case and this resulted in tear during the CCC.

Dealing with these problems strategically was the major challenge for the trainees in particular. The phacoemulsification was continued and completed in all the patients, though sometimes this meant transferring the surgery to a more senior surgeon. No other complication occurred in any of the cases and all had IOL in the bag placement.

Best-corrected visual acuity at 2 weeks is as shown in Figure 6.

Ocular comorbidity included age-related macular degeneration in two patients with 6/9 (0.67) vision, one patient

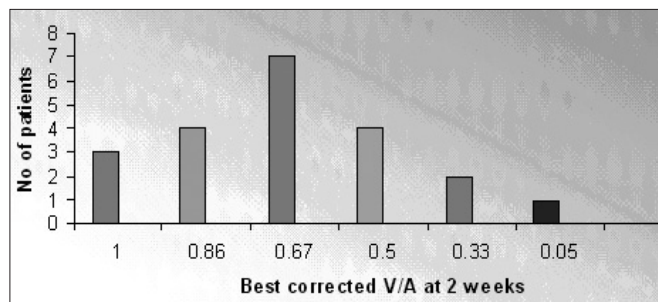


Fig. 6 - Postoperative visual acuity (in decimal) achieved by the patients.

with vision of 6/20 (0.33), and advanced glaucoma in one patient with 6/18 (0.33). Another patient had a macular scar and the postoperative visual acuity was 3/60 (0.05). Postoperatively, no cystoid macular edema or retinal detachment was noted in any of the cases at the last examination.

## DISCUSSION

In our series, over 50% of the breaches involved radial tears during the CCC. Mastering the technique therefore remains crucial for successful modern day cataract surgery. This means being able to perform it under varying circumstances such as in deep socket, small eyes, shallow anterior chamber, white cataract, and in children by making suitable adjustments to the technique.

The anterior lens capsule, like all membranes, is made of molecules with intermolecular bonds which undergo stress (force per cross-sectional area of the applied force) when a force is applied. As the force increases, it will begin to deform and if the strain (change in length of the deformed material per its original length) is increased just beyond its elastic limit, the material will become permanently deformed even after the stress is discontinued. Stress usually increases but as the material's breaking point is approached, it decreases. This is the point where the intermolecular bonds become broken and it tears apart (6, 7).

In CCC, once the flap is raised and when using the cystotome, the tip is placed 2 to 3 clock hours from the point of tearing such that the result is shearing where all the pulling force is concentrated at the point of tearing and is in the same direction as the tear (controlled and predictable tearing). If the cystotome is placed closer and directed more towards the center (ripping technique) the

force used in pulling develops a vector component and since the stress required at the breaking point is less than that required to reach this point, surplus force results, which will propagate the tear even if no more force is applied, provided the needle is firmly held at this point. Also the force is distributed over a larger area and as such more force is needed to initiate a tear than in shearing. Ripping technique is therefore more difficult to control and more likely to extend peripherally.

However, when abrupt change of the direction of tear is required, the ripping method is preferred because the surgeon can use sufficient pulling force in the desired direction so that the capsule becomes distorted both microscopically as well as macroscopically.

In the study, 60% of the tears, most being radial, were related to inexperience. In most of these cases the surgeon was a trainee. When those related to inadequate management of increased vitreous pressure and faulty focusing of the operating microscope are added (15% and 10%, respectively), the figure rose to 85%. It is known that increasing vitreous pressure results in anterior displacement of the lens with resultant stress on the zonules. This stress is in turn transmitted to the site of the capsulorhexis tear, making it to extend peripherally, sometimes even without manipulation (8). Koch (3) stated that this imbalance in pressure is probably the most common cause of uncontrolled peripheral tear. Injecting viscoelastics into the anterior chamber will deepen it and keep the anterior capsule flat to allow safe continuation of the rhexis.

The second most common period when there was breach rhexis (20% of them) was during the phacoemulsification itself. The phaco tip is as sharp as if not sharper than a razor blade; it can easily tear any part of the capsule during the procedure if appropriate caution is not observed. Inexperience (including judgment errors and faulty focusing) all contributed to tears during this stage. During phacoemulsification, it is important to groove within the limits of the capsulorhexis initially and only groove peripherally when deep in the nucleus. Another important factor is knowing the depth suitable for cracking the nucleus and the amount of force needed to crack the sculpted or grooved nucleus. Equally important is to use mainly aspiration with minimum phacoemulsification power to bring the nucleus into the center and away from the anterior and the posterior capsule to prevent compromising their integrity.

Lee (9) reported that tangential deviations towards the equator usually occurred at the 3 or 9 o'clock positions.

In our cases, the radial tears occurred in all the quadrants in the right eye, though more so in the superior half, but in the left eye, more occurred in the 9 to 12 o'clock region. In none of our cases did the tear extend to the posterior capsule and this differed with the findings of Davison (10). The procedure continued to completion in all patients, with adjustments in the technique. The phaco tip was always kept well away from the quadrant where the tear occurred during the phacoemulsification and in one case where there were two anterior capsular tears, a nasal corneal incision was made in order to continue the surgery with the phaco tip well away from these breach sites. Low vacuum and low power as advocated by Osher et al (11) was used to prevent sudden change in the fluid and anterior chamber dynamics. Also during the irrigation and aspiration, extra care was always taken to ensure that the flapping torn capsule is not engaged and thus inadvertently pulled with disastrous consequences such as vitreous loss.

Corrected visual acuity of 6/12 or better was recorded in all but three cases (i.e., 85% of cases) and these had comorbidity indicating that the reduced vision was not primarily the result of the surgical complication.

Thus, with careful management, phaco surgery can be completed with posterior chamber IOL implant in most cases even if the rhexis is breached and with good results. In situations where a trainee surgeon is involved, an early decision should be made as to whether a more senior colleague should complete the procedure, based on the level of training or experience of the trainee.

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