Capsulorhexis in White Intumescent Cataracts: The Five Commandments to Follow

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ABSTRACT
We describe a surgical technique for achieving a successful capsulorhexis in white intumescent cataracts. Raised intra-lenticular pressure is responsible for the high incidence of peripheral extension of the capsulorhexis (Argentinian Flag Sign) in intumescent cataract surgery. Swollen anterior and posterior sub-capsular cortex is responsible for the high intra-lenticular pressure. We present surgical strategies in the form of five commandments, which would ensure better success rates in achieving capsulorhexis in intumescent cataracts. These five commandments are based on the surgical principles of maintaining positive pressure in the anterior chamber and performing a two staged sequential active decompression of the swollen capsular bag and a two staged capsulorhexis. These strategies aim at gradual decompression of the swollen capsular bag, which will ensure a less tense anterior capsule and better control over the tearing anterior capsule.

KEY WORDS: Capsulorhexis, cataract, decompression, intumescent

INTRODUCTION
White intumescent cataract continues to be a challenge for the modern day cataract surgeon despite the recent technological advances. Achieving a complete continuous curvilinear capsulorhexis (CCC) is difficult as, the raised intra-lenticular pressure greatly increases the risk of the capsulorhexis extending peripherally towards the equator. The difficulty in completing CCC in these eyes is compounded by the poor visibility following the release of the liquid cortex into the chamber once the anterior capsule is punctured.

The initial puncture of the anterior capsule of these swollen lenses can extend radially, sometimes simultaneously in both directions as the nucleus bulges up.

The incidence of incomplete capsulorhexis associated with white cataract surgery has been reported to be from 3.85% to 28.3%.[1-4] Sometimes the anterior capsular tear may extend beyond the equator and lead to more serious complications such as a posterior capsular tear, vitreous loss, nucleus drop and dislocation of the intraocular lens (IOL).

Various techniques have been described in the past to deal with this difficulty:
1. Performing CCC under air[8]
2. Decompressing the swollen lens with a needle[9]
3. Aspirating the liquefied cortex from the eye, and performing a two stage CCC[1,6,7]

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4. Staining the capsule to improve visualization\(^{[10]}\)
5. Performing CCC in a closed chamber with a needle and pressurized with balanced salt solution\(^{[11]}\)
6. Two staged rhexis after depressurizing the posterior compartment of the lens\(^{[12]}\)
7. Iridotomy\(^{[13]}\)
8. Using an endo-illuminator to improve visualization\(^{[5]}\)

These techniques have significantly improved the results in white cataracts, however, the ‘Argentinian Flag’ sign continues to occur.\(^{[14]}\)

**UNDERSTANDING THE PROBLEM IN WHITE INTUMESCENT CATARACTS**

There is high intra-lenticular pressure in these swollen lenses. Once the anterior capsule is punctured, there is rapid equalization of the hydrostatic pressure within the relatively pressurized intra-lenticular compartment and the relatively depressurized anterior chamber, which is the reason for the rapid radial extension of the punctured anterior capsule towards the equator, which is often described as the Argentinian Flag Sign.

Swollen lens cortex is the reason for the high intra-lenticular pressure. It is important to note that there are two compartments of the swollen cortex, one anterior to the nucleus and the other being posterior to the nucleus (Figure 1).\(^{[12]}\)

The swollen cortex in the anterior compartment makes the anterior capsule tense and once the anterior capsule is punctured the pressure in this compartment will be released, and we may initiate a rhexis, but the pressure from the posterior compartment (swollen cortex behind the nucleus) pushes the nucleus forward, which increases the chance of the capsulorhexis running away radially towards the equator. Hence both the anterior and the posterior compartments must be decompressed to achieve control over the tearing anterior capsule to complete capsulorhexis.

We describe our surgical strategies to overcome the difficulties while performing CCC in white intumescent cataracts.

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**Figure 1**: High intra-lenticular pressure is because of the swollen cortex in the two compartments, A - Anterior to the nucleus and B - Posterior to the nucleus

**Surgical technique**

We prefer to use intravenous mannitol 20% 250-300 ml about 60 min prior to surgery in all cases with intumescent cataracts. Mannitol will not depressurize the swollen lens but helps in maintaining good positive pressure in the anterior chamber. The surgery is performed under topical or peribulbar anesthesia.

The anterior capsule is stained with 0.1% trypan blue after making two side ports.

The five commandments while performing CCC in white intumescent cataracts:
1. Positive pressure in the anterior chamber: Positive pressure in the anterior chamber prevents the sudden release of pressure from the swollen lens once the anterior lens capsule is punctured. We use 1.4% sodium hyaluronate a cohesive viscoelastic agent to achieve this. It serves two purposes: (1) The high-density cohesive viscoelastic agent pressurizes the anterior chamber and flattens the anterior capsule, (2) when sodium hyaluronate is first injected on top of the center of the anterior capsule it displaces the underlying anterior subcapsular cortex away from the center. This depressurizes a small central zone of the anterior compartment of the lens bag, which helps in better control of the punctured anterior capsule and also minimizes the immediate egress of the cortex into the anterior chamber, and aids in better visualization.
2. Decompression of the swollen lens: This can be achieved effectively by using the bimanual irrigation aspiration system to puncture the anterior capsule and aspirate the small amount of the underlying cortex (Figure 2). The non-dominant hand holds the irrigating handpiece and the dominant hand holds the aspiration hand piece to which the 26 G bent capsulotomy needle has been attached. The rhexis is initiated by making a small c-shaped incision on the anterior capsule and folding the capsular tag on itself. At this stage the needle is introduced under the anterior capsule, and a small amount of anterior subcapsular cortex is aspirated which reduces the raise intra-lenticular pressure (Figure 2). This makes the capsule less tense and makes the initiation and completion of the mini rhexis easy.

3. The small mini rhexis: Although the anterior compartment of the lens is decompressed, there is still enough pressure in the posterior compartment of the lens owing to swollen posterior subcapsular cortex. The usual sized rhexis still runs the risk of radial extension. Hence the initial rhexis has to be a mini rhexis of about 3 mm. This is achieved either with the same cystitome used for the initial puncture of the anterior capsule or with a micro capsulorhexis forceps used through the side port incisions (Figure 3). All the maneuvers are performed through the side port to maintain positive pressure in the anterior chamber and to minimize the egress of the viscoelastic agent.

4. Decompressing the lens, releasing the pressure in the posterior compartment: The pressure in the posterior compartment of the lens has to be released before we enlarge the rhexis to an optimum size. This is achieved by using the bimanual irrigation aspiration system to aspirate the cortex under the anterior capsule present up to the equator (Figure 4). Then the nucleus is gently moved with both cannulas to allow the posterior trapped cortex to flow out across the equator of the nucleus to be aspirated by the aspiration cannula. Once the posterior trapped cortex and fluid is released the lens is now truly depressurized.

5. Enlarging the rhexis: Under the cover of cohesive viscoelastic the mini rhexis margin is snipped tangentially with a micro capsulorhexis scissors (Figure 5). Radial cuts at the rhexis margin have a risk of running away toward equator hence tangential cuts are preferred. The rhexis is then enlarged to an optimum size of 5 mm using a capsulorhexis forceps (Figure 6). At this stage

![Figure 2: Cystitome attached to the aspiration hand-piece of the bi-manual irrigation aspiration system. The sub-capsular cortex is being aspirated to decompress the bag](image1)

![Figure 3: A small “mini rhexis” of about 3 mm is created using the micro capsulorhexis forceps through the side port](image2)

![Figure 4: The equatorial cortex is being aspirated by using the bi-manual irrigation aspiration cannula and nudging the nucleus gently allows the posterior cortex to flow across the equator of the nucleus to be aspirated by the cannula](image3)
we can also use the regular capsulorhexis forceps through the main wound since the capsule is not tense and behaves predictably.

After completion of the rhexis, phacoemulsification of the nucleus is performed using the surgeon’s preferred technique and after the residual cortex aspiration a foldable IOL is placed in the bag.

We used these surgical techniques on 92 eyes with white intumescent cataracts operated by a single surgeon (D.M) between November 2013 and January 2015. Radial extension of the CCC was observed in two eyes (2.17%). The incidence of radial extension of CCC in 2.17% of the eyes with this technique is significantly less when compared to the previously reported incidence of 3.85-28.3%.[1-4] In one eye the radial extension occurred immediately after puncturing the anterior capsule and in the second eye it occurred during the enlargement of the mini rhexis. None of the eyes had a posterior capsule tear.”

To summarize, maintaining positive pressure in the anterior chamber, actively depressurizing the capsular bag and performing a two-staged CCC are critical surgical principles, which help us to achieve complete CCC in these white intumescent cataracts.

REFERENCES


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