ISSN: 2090-9047
Online ISSN: 2536-9466

Review Article/JORS
Gomaa A etl., 2017, 1(1):31-38

JOURNAL OF OPHTHALMOLOGY AND RELATED SCIENCES

Must Know Cornea for Cataract Surgeons

A Practical Guide

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Submitted: 20-6-2017; Revised: 3-7-2017; Accepted: 10-7-2017

The Cornea is the main refractive medium of the eye[1]. Corneal health and clarity are essential requisites for any successful cataract surgery[2]. Relation between cornea and cataract surgery works reciprocally in an interrelated way. In this review, we are going to discuss factors that need to be considered by cataract surgeons looking for safe surgery and satisfactory outcome. The following topics will be discussed:

- Corneal signs to be looked for during preoperative cataract assessment
- The effect of corneal pathology on cataract surgery
- Precautions to be taken during surgery in presence of corneal pathology or previous corneal surgery
- Corneal complications of cataract surgery and how to manage them

1. Preoperative Examination:

Preoperative examination of cataract patients, whether carried by a comprehensive ophthalmologist or a specialist anterior segment surgeon, should include detailed slit lamp examination of the cornea. There are some corneal signs, which should alert the cataract surgeon and guide him/her through risk stratification of cases scheduled for surgery.

a. Corneal clarity:

Detection of corneal cloudiness and opacities is usually the first to encounter during the slit lamp examination and the easiest to note. This is not absolutely true in all opacities, being more difficult with fainter and eccentric opacities. Special attention should be paid for fainter opacities detected during slit lamp examination as it may be more troublesome during surgery with

use of the surgical microscope. Scatter of the microscope coaxial light rays during surgery may result in intensifying the effect of the opacity and unanticipated difficulty during capsulorrhexis and phacoemulsification of the nucleus[3]. Clear description of the corneal opacity preoperatively should include site, size, and depth. Labelled corneal drawings, front and cross-sectional, are very helpful and results should be considered while stratifying patients according to their risk for surgery.

b. Corneal size:

Noting corneal size is not done routinely during preoperative assessment of cataract patients. Existence of abnormal findings should alert the surgeon to document the findings clearly and use it while planning for surgery. The average corneal diameter is 11- 12 mm with the vertical diameter being shorter than the horizontal[4]. Measurement of the corneal diameter will be helpful if use of anterior chamber intraocular lens (ACIOL) is warranted during surgery. The slit lamp can be used to measure the corneal diameter but it is not accurate; the maximum length of the slit beam is 8 mm. Using a mark on the iris, one can still measure with two adjacent beams. A ruler is more accurate. Intraoperatively, a caliber can be used. Despite being more accurate than other measures, it does not allow enough time to get the IOL needed for implantation in some settings. After deciding on the power needed, the overall diameter of the ACIOL to be used can be calculated by adding one millimeter to the white to white diameter measured before or during surgery.

c. Corneal shape:

Detection of corneal shape during slit lamp examination might be the simplest way to predict the corneal radius of curvature and anticipate difficulties and inaccuracies in measurements while preparing for surgery. Attention to signs of kertaoconus will save the examiner and his clinical team extra effort needed to explain abnormal findings detected later on while carrying out different scans and IOL measures. It will also guide them to order other confirmatory tests as corneal topography.

d. Corneal vascularization:

The cornea is known to be avascular[5]. Presence of corneal vascularization can be related to common causes as use of contact lenses and chronic hypoxia, but it can also indicate the presence of serious pathologies as immunologic disorders and severe ocular surface disorders. Peripheral corneal thinning in presence corneal vascularization should alert the examiner for such possibility and necessitates further assessment as well as referral to a trained cornea specialist. Surgery in some of these conditions as ocular cicatricial pemphigoid (OCP) without proper control and immunosuppression might result in catastrophic outcomes with loss of the eye[6,7]. Documentation of corneal vascularization includes number of clock hours involved, severity, depth and extent of invasion into the cornea in reference to the limbus[8]. A diagram will be very helpful to visualize changes and follow up patients before and after surgery. It is also very helpful while planning the surgical wound site. Suturing might be warranted in some of these cases with peripheral corneal thinning.

e. Corneal thickness:

Corneal thickness is a true reflection of health of the corneal endothelium. The average corneal thickness is 540μm[9]. Coexistence of corneal cloudiness, even minimal, makes it even more suspicious of pathological insult. It is recommended in such cases to order two more

tests prior to the surgery; corneal pachymetery and specular microscopy. Time of slit lamp examination should be noted, variation in corneal thickness is known to happen as the day goes on, with decrease in corneal thickness towards the end of the day. Due to subjectivity of the corneal pachymetery, different points across the cornea should be measured and noted in the examination chart[10,11]. Some cases will benefit from having specular microscopy done preoperatively.

Previous intraocular surgeries as aphakia, implants and ocular devices in the anterior chamber as glaucoma tubes and ACIOLs, point to the need of having the endothelial cell count done and documented preoperatively. It is also advisable to have it done in other cases with history of corneal grafts, acute angle closure glaucoma, and refractive surgery.

2. Corneal pathology and cataract:

a. Visualization during cataract surgery:

Having a clear cornea is an essential prerequisite for a safe cataract surgery. Corneal infection and resultant corneal scars remain the main etiology for loss of corneal clarity in developing countries where unsupervised use of contact lenses is a common practice[12]. Other causes of loss of corneal clarity include a long list of pathologies ranges from congenital, degenerative, metabolic, to traumatic insults. Effect of corneal scar on surgery remains to a big degree related to the severity of the pathology and depth of corneal involvement. An experienced cataract surgeon is usually able to handle most of the difficulties encountered during surgery as a result of lack of clarity, so grade of the operating surgeon should be decided carefully while listing patients with corneal pathology for surgery. Surgical technique during cataract surgery can be modified to minimize challenges in such cases. Use of capsular stains for the capsulorrhexis is recommended, even if the corneal opacity noted during examination appears to be faint[13]. As previously mentioned the corneal opacity might become more troublesome during surgery with use of the surgical microscope coaxial illumination. The benefits of using capsular stains are well published and significantly outweigh the risk of endothelial toxicity[13-15]. Injection of air prior to introducing the capsular stain might be helpful in minimizing the toxicity on corneal endothelium with more even distribution on the anterior capsule. Another successful technique to tackle challenges associated with corneal scaring is to use a fiberoptic or an endoillumination probe similar to those used during vitrectomy as a source for illumination[16]. This can be done as an adjuvant for the surgical microscope light or solely with the microscope light switched off. The fiberoptic needs to be held by an assistant and directed obliquely at the periphery through clear parts of the cornea, it can moved around as needed to assist in visualization during capsulorrhexis.

3. How to minimize cataract surgery damage on corneas with pathology

In this section we will discuss special considerations to be made during cataract surgery in order to minimize and avoid further damage whenever possible.

a. Fuchs corneal dystrophy:

Fuchs corneal dystrophy is one of the main indications of penetrating keratoplasty (PKP) in patients aged 50 years or older. Review of several studies done in North America identified Fuchs' corneal dystrophy as the second most common

indication for keratoplasty (15%) ranking second after pseudophakic bullous keratopathy (PBK) (38%)[17-19]. Significant proportion of patients with Fuchs dystrophy remain compensated for life and will benefit from cataract surgery to improve their vision, hence the need to minimize further damage on their corneas during cataract surgeries. Special precautions can be made to minimize further corneal damage in Fuchs dystrophy. Grade of operating surgeon and his/her level of experience remains a significant factor, and should be considered while listing patient for surgery. The level of surgeon's experience is known to affect the surgical time, effective phaco time and the power used during surgery, which in turn affects level of insult on the corneal endothelium. Other techniques to be used during cataract surgery for Fuchs' dystrophy include the following:

1. Time for surgery: It is recommended not to delay the cataract surgery in presence of Fuchs' dystrophy as harder nuclei need more power for phacoemulsification and hence increase the risk of endothelial damage. The timing for surgery has to be carefully discussed with the patient and guided by his visual potential and needs. The patient should be counseled about risks associated with having surgery to include the need for corneal transplant after surgery.
2. Scleral tunnel wound versus clear corneal incision: Some studies show that scleral tunnel may result in less endothelial cell loss and so will be preferable in cases like Fuchs[20].
3. Soft Shell technique: Combining both dispersive and cohesive viscoelastic was shown to minimize damage of corneal endothelium during surgery. This involves injecting a shell of dispersive viscoelastic to coat the internal corneal surface followed by injection of cohesive viscoelastic to maintain the depth of anterior chamber and facilitate other surgical steps[21].
4. BSS plus: There is some controversy on whether BSS plus offer added protection for the endothelium or not. If available and affordable, it is recommended for use, otherwise regular ringer's lactate can be used[22].
5. Phaco power modulation and technique: Reducing effective phaco time and power is recommended to minimize impact on corneal endothelial cells. Some studies show preferable effect for torsional phaco over conventional. Phaco chopping and quick chopping is a preferred technique for cataract surgery with Fuchs' dystrophy especially with harder cataracts as it involves delivering less power in the anterior chamber. It is important to note that a well-trained surgeon can deliver safer results with whatever technique they are comfortable with, so no need to specially modify the technique for cases with Fuchs as it implies more risk[22-24].

b. Special considerations in previous corneal graft (PKP, DALK and DSAEK)

Within 5 years after PKP, incidence of visually significant cataract was higher in patients who are 50 years of age or older. One of the factors to be blamed is the chronic use of steroids postoperatively[25]. Eyes with previous corneal grafts will benefit from being done by an experienced cataract surgeon, corneal graft decompensation is a possible complication of

cataract surgery and the following precautions should be taken to reduce risk:

1. Wound: Scleral tunnel is preferred in cases with previous corneal grafts (Descemet's stripping automated endothelial keratoplasty; DSAEK, PKP). Some ophthalmologists still consider clear corneal incisions, but they recommend extra vigilance while assessing the wound integrity at the end of surgery with lower threshold for suturing[20].
2. Viscoelastic: Generous use of viscoelastic during surgery is needed, with dispersive agents being preferred. Allowing few seconds during phacoemulsification between different quadrants with injecting more viscoelastic, offer more protection to the endothelium with dissipation of the heat generated at the tip of the phaco probe[21].
3. Phaco power modulation and technique: Same as in Fuchs' dystrophy, reducing effective phaco time and power is recommended to minimize impact on corneal endothelial cells. Some studies show preferable effect for torsional phaco over conventional. Phaco chopping and quick chopping is a preferred technique for cataract surgery[23].
4. Postoperative: Patients with previous PKP will benefit from increased frequency of topical steroids immediately postoperatively. Steroids should be tapered gradually over 6-8 weeks to reduce the likelihood of rejection episodes.

c. Previous Radial Keratotomies (RK):

Radial keratotomy to correct refractive errors was first described in 1974[26]. With the introduction of excimer laser refractive surgery in the 1990s, RK fell into disuse and it is not practiced nowadays. Despite this, it is still possible to come across some cases presenting for cataract surgery. Ophthalmologists should be aware of the risks associated with these cases and how to minimize them intraoperatively.

1. Wound construction: Scleral tunnel is preferred over clear corneal wound in cases with previous RKs. Some authors still choose their technique based on the number of corneal cuts and the distance between them. The consensus is to avoid clear corneal incision in any patient who had more than 8 cuts with short distance between them, which does not accommodate the incision. If corneal incision is done, it is recommended to avoid intersection with the corneal cuts as it may end up in unzipping the corneal incision with resultant free corneal flap[27].
2. Bottle height: Corneas with RKs are generally weaker than normal with potential risk of breaks in the residual stroma and Descemet's membrane at the bottom of the keratotomies. These breaks can range from small microscopic breaks to big open wounds. Lowering the bottle height during phacoemulsification and having lower flow reduces pressure in the anterior chamber and subsequently lower the risk of such breaks.
3. Postoperatively patients are noted to have fluctuation in their refraction postoperatively due to swelling of corneal wounds and flattening of central cornea resulting in hyperopic shift. Patience should be practiced with these

cases as they usually resolve within 6 weeks after surgery.

4. Corneal complications of cataract surgeries:

In this section we will discuss corneal complications of cataract surgery and how it can be best managed.

a. Intraoperative:

i. Corneal abrasions:

Common sites for iatrogenic corneal abrasions related to cataract surgery include lips of the corneal wound and across the intrapalpebral cornea. The first is related to the frequent grasping of the wound edges during surgery; it is mostly insignificant and heals within few days after surgery. The second is a linear abrasion which happens inadvertently while cutting through the surgical drape with scissors or due to slippage of other instruments as speculum. Abrasions need to be documented in the surgical record, patient warned for possibility of pain and/or foreign body sensation after surgery. Antibiotic ointment for the first few days may help to ease pain and fasten healing. Some recommend placing a soft contact lens for comfort immediately postoperative.

ii. Wound phaco burn:

Wound burn happens in some cases where prolonged phaco power was used with tighter wounds. Attention should be paid for cases with harder nuclei to have proper wound construction (size of the wound) and time management during surgery. Allowing few seconds during phacoemulsification between different parts of the nucleus permits circulation of fluid through the sleeve with cooling of the tip. If burn is detected, it is recommended to suture the wound[28]. Hydrating the wound won't be enough to secure it with higher risk of gaping postoperatively and subsequent risk of infection. Postoperatively, patients will benefit from more frequent steroids for the first week.

iii. Descemet's membrane detachment:

Despite being less frequent in modern cataract surgery done through small incisions, one can still encounter some cases during surgery. It is more common with more anteriorly placed corneal wounds and frequent instrument manipulation during surgery. When encountered, it is usually small and does not necessitate any management. In some cases with bigger detachments, injection of air in the anterior chamber and postoperative positioning may be needed[29].

iv. Postoperative corneal edema:

Postoperative corneal edema ranges from transient mild edema which lasts for few days to the more severe PBK or aphakic Bullous keratopathy (ABK) with permanent damage to the corneal endothelium. Predisposing factors involve cases as Fuchs, previous acute angle closure glaucoma, harder nuclei, anterior chamber phaco, and junior surgeons[8]. When detected postoperatively in presence of epithelial edema, it is important to check the IOP. Most of these cases are due to retained viscoelastic and resolve within 2-3 days after surgery. Cases with stromal edema and striate keratopathy will benefit from more frequent steroids and hypertonic saline, which may fasten the visual recovery. Most of the corneal edema cases resolve completely within 3-4 weeks after surgery, so no need to rush to the conclusion of

permanent endothelial damage and consequent need for PKP or DSAEK early postoperatively.

FINANCIAL DISCLOSURE The authors declare no financial interests to disclose.

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