Corneal Opacity Management

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Cornea is an optically clear and transparent structure. Corneal disorders can result in deposition of additional material (e.g., fluid, scar tissue, inflammatory debris, metabolic byproducts) within one or multiple layers of the cornea causing loss of corneal clarity. This loss in corneal transparency is called as corneal opacity. Corneal diseases represent the second leading cause of blindness in most developing world countries. Nearly 80% of all corneal blindness is avoidable.

Keratitis and trauma are the most frequent causes of corneal blindness in developing countries. Important causes of corneal opacity includes following:

**Prevention and Early Detection**
- Neonatal corneal opacification caused by forceps injury, herpes simplex keratitis, or bacterial keratitis can be prevented.
- Use of protective eyewear at work, in sports, and in armed conflict can reduce trauma.
- Early diagnosis and treatment of bacterial keratitis can reduce scarring and opacification.
- Appropriate treatment of the trichiasis, corneal exposure, dry eye, neurotrophic cornea, and autoimmune disease can reduce the incidence of ulcerative keratitis associated with them.

**Managements**
Therapeutic strategy includes optical, medical, and surgical alternatives.

**Different aspects of managements**
Rationale for treatment is only when corneal opacity is associated with functional visual loss or discomfort. Less commonly, cosmesis is an indication for treatment. Stromal or endothelial dysfunction or disease may necessitate intervention to stabilize the ocular surface to prevent further complications. Few important things should be considered before any planning for treatment, like;

1. Severity, site and depth of opacity:
   a. Small central/paracentral/ peripheral (full thickness or partial thickness) but involving part of pupillary opening (Figure 1).
Refraction with corrective glasses or contact lenses (both assessed with dialated and undialated pupil to consider for optical iridectomy), with or without cosmetic corneal tattooing /cosmetic contact lenses.

b. Small, peripheral opacity not involving part of pupillary opening (full thickness or partial thickness).

These opacities may still compromise vision by inducing distortions of the corneal curvature. Refraction over a rigid contact lens can be helpful in assessing potential visual acuity and may in itself improve visual acuity. Also corrective glasses can be prescribed.

c. Larger size corneal opacity involving pupillary opening, no improvement in vision after dilation

- If only nebular corneal opacity and visual requirement is not much or any systemic or local disorders not allowing for surgical correction then refraction for fitting glasses and contact lenses, otherwise laser assisted corrections PTK, lamellar surgical corrections (manual, microkeratome, femtolaser assisted) (Figure 2a,b,c).

- If deeper corneal involvement then depending on depth of involvement LK, DALK (manual, microkeratome, femtolaser assisted) .Rotation autograft is another option.

- If full thickness corneal involvement/ adherent leukomatous opacity is there and eye bank facility is present then pkp could be options (Figure 3).

2. Associated other vision decreasing problems

Like cataract, astigmatism, posterior segment disorders etc. should be evaluated first then appropriate treatment should be planned.

3. End stage disorders without visual potentials

Like in phthisical cornea or end stage glaucoma patients with opacity, should be treated for pain and discomfort also for cosmesis like corneal tattooing, contact lenses, artificial eyes etc.
Treatment

Depending on the etiology of the opacity, severity, needs and health status of patient, treatment may be optical, medical, surgical, or a combination.

Optical and Medical Treatment

Treatment of conditions like epithelial corneal edema, poor ocular surface, high IOP or intraocular inflammation, helps to improve visual and overall function also alleviate discomfort or pain (Figure 4a,b). Treatment may be necessary for underlying systemic disorders such as immunocompromised status or connective tissue disease.

Vision impairment may be reduced or eliminated by spectacle or contact lens correction. Contact lenses are good option for treatment of corneal scaring. Corneal tattooing/cosmetic contact lens can be an option for rehabilitation, especially in patients where there was no option of functional improvement by other treatments.

Surgical Treatment

Selection of the surgical procedure is determined by the depth and location of the opacity. The proposed surgery should have an acceptable risk/benefit ratio with the potential to reduce the patient’s disability significantly. Procedures that may improve vision include the following:

- **Optical iridectomy:** where cornea overlying the potential iridectomy site is clear and there is a high risk of complications for PK, e.g., Peter’s anomaly.
- **Chemical treatment/EDTA chelation:** used for removal of calcific band keratopathy.
- **Limbal stem cell graft:** may be useful to restore the corneal epithelium. An amniotic membrane graft may be considered as a supportive substrate for the epithelium.
- **Lamellar procedure:** (Involves selective removal and replacement of diseased corneal layers)
  1. **Lamellar keratectomy:** may improve corneal clarity and smoothness in cases of anterior stromal scarring associated with normal endothelial function.
  2. **Mechanical superficial keratectomy:** works best for opacities overlying Bowman’s layer and superficial degenerations such as epithelial membrane dystrophy and Salzmann nodular degeneration.
2. **Lamellar keratoplasty**: useful in anterior to mid-stromal opacities in which endothelial function is normal.

   a. **Superficial Anterior Lamellar Keratoplasty (SALK)**: Particularly when treating deeper lesions which can not be treated by PTK. This procedure can be Automated or Hemi-automated (HALK, cutting host bed with microkeratome) suture assisted or sutures less with glue.

   b. **Anterior Lamellar Keratoplasty (ALK)**: Manual, Automated (microkeratome assisted) donor graft can be sutured into the recipient bed or suture assisted with glue.

   c. **Sutureless Femtosecond Laser - Assisted Anterior Lamellar Keratoplasty (FALK)**

   Depth of the recipient corneal pathology is measured using anterior segment OCT (AS-OCT). A femtosecond laser is used to create the lamellar cut in the recipient with donor corneas. Donor cut is adjusted according to the depth of the lesions with an additional 10-20% thickness adjusted to compensate for donor tissue swelling. After putting donor lenticule the incision is dried, and flap adhesion is checked. A bandage soft contact lens is placed over the cornea.

   d. **Deep Anterior Lamellar Keratoplasty (DALK)** (Figure 5a,b).

   It removes and replaces total or near-total corneal stroma while preserving host endothelium. The advantages of DALK include reducing the risk of endothelial graft rejection, efficient visual rehabilitation relative to PK, and also fewer complications including expulsive hemorrhage, anterior synechia, postoperative endophthalmitis, and glaucoma in comparison to PK. This procedure also requires less rigid criteria for donor corneal tissue selection that is often weighted toward donor endothelium in PK. There are different methods of dissections of host cornea like; direct Open Dissection (Anwar in 1972), closed Dissection (Melles Technique, 1999), dissection with Hydrodelamination (Sugita and Kondo), dissection with Big Bubble Technique, (Anwar’s 2002), Big Bubble technique Combined with Femtosecond Laser Trephination. (Suwan-Apichon et al. 2006 and Price Jr. et al. 2009).

   e. **Posterior Lamellar Keratoplasty or Endothelial Keratoplasty (EK)**

   Attempting to replace endothelial pathology, the first (PLK) procedure was described by Barraquer in 1950. Melles et al. offered sutureless PLK in 1998, using an air bubble for graft fixation. In 2001, Terry and Ousley introduced endothelial keratoplasty (EK) and deep lamellar endothelial keratoplasty (DLEK). Later in 2005 Price Jr. and Price performed Descemet stripping endothelial keratoplasty (DSEK). A year later, Gorovoy added automation using a microkeratome for Descemet stripping automated endothelial keratoplasty (DSEA). Subsequently, Descemet membrane endothelial keratoplasty (DMEK) was described by Melles et al. allowing transplantation of an isolated endothelium-Descemet membrane layer (EDM) without adherent corneal stroma. Later on Price et al. described Descemet membrane automated endothelial keratoplasty (DMAEK). Endothelial keratoplasty has lesser risk of
endothelial graft rejection, early visual rehabilitation relative to PK and also fewer complications. Two most common early complications following DSAEK surgery are graft dislocation (1 to 82%) and primary graft failure (0-29%).

- Rotation Autograft:
  Rotational autograft can be an effective alternative to standard penetrating keratoplasty for some patients with corneal scars. Area of clear cornea is placed in the geometric center of the cornea and the opacity is rotated toward the limbus. The objective is to achieve the largest possible optically clear zone. Mathematical variables are set to maximize postoperative visual acuity and for generalization of the geometric model\(^3\).

- Penetrating keratoplasty:
  Penetrating keratoplasty should be performed when nonsurgical measures or less invasive procedures not provide satisfactory visual outcome. Long term follow-up care and patient cooperation are required to ensure success. Patients remain at risk for allograft rejection throughout life. There are various complications following Penetrating keratoplasty including Intraoperative and Postoperative complications.

- Triple procedure:
  It involves cataract surgery and intraocular lens implantation along with lamellar, DSEAK and PKP procedure. Mostly open sky cataract surgery done in PKP with cataract surgery in case of PKP planned with closed chamber cataract surgery to increase visibility, Lamellar corneal dissection for visualization of the anterior chamber before triple procedure can be done\(^4\).

- Keratoprosthesis:
  Used for severe corneal bilateral opacity where other surgical options are not viable.

- Conjunctival flap:
  Surgical procedures to reduce the pain of corneal edema (bullous and microcystic) in patients who are not candidates for corneal transplantation.

So each case of corneal opacity should be evaluated properly then managed. After visual rehabilitation, postoperative care as well as treatment of complications and recurrent disease is also important.

References


