Cataract Surgery Techniques and Effects in Mature Senile Cataract: Review Article

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ABSTRACT
Background: One of our most cherished belongings is our ability to see well. The ability to see clearly is a fundamental human right. People fear losing their sight the most according to surveys. As we age, we are more likely to suffer from vision issues. The typical age of cataract onset in the West is around 60 years old, however in poorer countries it is more common around the age of 45 or even earlier. Since cataracts are responsible for 47.8 percent of the world's total blindness, they are a major cause of concern and a significant public health issue in developing countries.
Objective: This study aimed to study the corneal endothelial changes in both procedures for extraction of mature senile cataract.
Conclusion: Corneal endothelial cells are sensitive to trauma, which affects cell density and cell morphology. Endothelial cell loss during surgery affects the ability of the cornea to preserve transparency with subsequent visual affection.
Keywords: Cataract surgery techniques, Mature senile cataract.

INTRODUCTION
Cataract surgery: Cataract surgery is the most commonly done surgical technique on these patients for the purpose of visual rehabilitation. There has been a massive increase in surgeries due to enhanced safety and results of surgical and lens technology. Manual Small Incision Cataract Surgery (MSICS), and Phacoemulsification have made significant breakthroughs in cataract surgery throughout the years. Basically, current cataract operations are divided into two categories: machine-independent Manual Small Incision Cataract Surgery, and machine-dependent Phacoemulsification. A massive and ever-increasing backlog of cataract blindness continues to be the primary obstacle in the treatment of cataracts despite substantial technological breakthroughs [(1)].

Figure (1): Showing mature senile cataract [(1)].

There are an estimated 19 million persons worldwide who are blind because of bilateral cataracts. Intumescent, mature, and super mature lenses (white cataracts) make up a considerable component of the backlog of cataract procedures in underdeveloped countries. What is a white cataract? It is described as complete opacification of the crystallized lens that prevents any red reflex from being viewed, regardless of its cause. Phacoemulsification has become the standard treatment for white cataracts in affluent countries with the introduction of capsule dye. Most underdeveloped countries, including India, are unable to use phacoemulsification due to the expensive expense of disposable supplies, and phaco-machines as well as necessity for more advanced surgical training [(2)].

The aim of the present review was to study the corneal endothelial changes in both procedures for extraction of mature senile cataract.

Phacoemulsification and corneal Affection:
Phacoemulsification has become the most common surgery to treat cataract. It possesses many benefits more than alternative type of cataract removal surgeries as regard terms of safety, acceptance and rapid visual rehabilitation. Despite the wide advantages of phacoemulsification, it still has a known negative impact on corneal endothelium. With the recent advances in the technology of the phacoemulsification machine and surgeons skills, surgeons expand the use of phacoemulsification to operate on mature senile cataracts with hard lens. This is associated with high damage to endothelium [(3)].

Damage to the corneal endothelium layer causes corneal edema, which can lead to permanent bullous keratopathy. Because corneal endothelial cells are unable to renew, corneal tissue transplantation is the only effective treatment. Cataract surgery was found to be the most common cause of penetrating keratoplasty in a recent Japanese national survey of bullous keratopathy (24.2 percent) [(4)]. After Fuchs endothelial dystrophy, cataract surgery was ranked second in a recent study in the United Kingdom as an indication for endothelial keratoplasty [(5)].

Damage to the corneal endothelium during phacoemulsification: causes and consequences:
Damage to the corneal endothelium during phacoemulsification has been reported to be caused by an

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excessive amount of ultrasonic energy colliding with lens nuclear fragments and a localized increase in temperature. IOP as a cause of corneal endothelium injury is getting scant attention at the moment. As an immediate measure of fluid flow in the anterior chamber, intraoperative IOP can be considered. The corneal endothelial damage caused by the turbulence of irrigating fluid has previously been explored only from the lens nucleus's perspective. The corneal endothelium's response to increased IOP or changes in intraoperative IOP has not yet been thoroughly understood [(3)].

Increased aqueous humour temperature due to ultrasound energy is another cause of corneal endothelial injury. Radiation energy and stroke length have a direct correlation to the temperature rise of 2°C to 20°C. The temperature of the anterior chamber rises when the stroke length is lengthened [(6)].

During phacoemulsification, the corneal endothelium can be damaged by the production of free radicals. The presence of free radicals in the anterior chamber may be one of the most detrimental variables during this treatment because of the oxidative damage they bring to endothelial cells. It has previously been shown that high-intensity ultrasound oscillation in an aqueous solution can produce free radicals. Acoustical cavitation produces shock waves that cause localized pressures of 600 atmospheres and temperature rises of 5000 K, resulting in free radicals. H_2O molecules are broken down into hydroxyl radicals and hydrogen ions as a result of the energy, which is more reactive than any other reactive oxygen species. When phacoemulsification is performed, free radicals are released, and intraoperative viscoelastic devices (OVDs) can be used to trap these free radicals. The lower the concentration of free radicals in the anterior chamber, the longer the OVD retention duration. Thus, the application of dispersive or visco-adaptive OVDs reduces endothelial damage significantly [(7)].

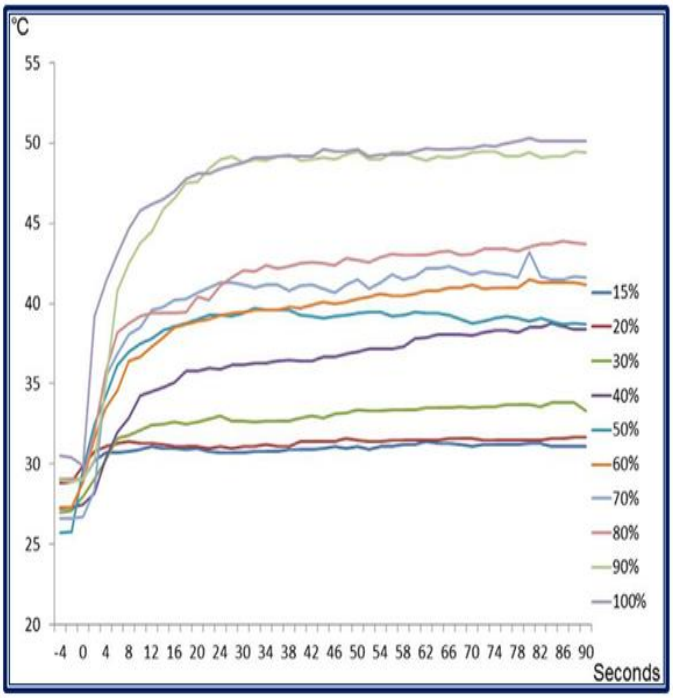

Figure (2): Change in the anterior chamber temperature against ultrasound time at different ultrasound powers used [(6)].

The effect of phacoemulsification on the corneal endothelium versus cataract surgery with a minor manual incision:

Phacoemulsification has a higher rate of edematous corneas compared to MSICS, which is typically regarded to produce less endothelium damage. Even when it comes to MSC, the question of which approach is more endothelial-friendly remains for MSC, considering the widespread clinical experience of corneal edema following phaco, MSICS or a referral to an ophthalmologist with knowledge in the procedure should be considered in the case of extremely dense brunescent or black cataracts, according to many researches [(8)].

Preoperative consideration for cataract surgery in mature senile patient:

The best postoperative outcomes and, more significantly, a grateful patient, can be achieved with any type of surgery when the preoperative evaluation is thorough and thorough. Prior to surgery, patients should be screened as follows for SICS:

Full medical history:

The patient's full medical history should be gathered [(9, 10)]:

- Patients with diabetes are more likely to develop post-operative uveitis, neovascularization of the iris, and diabetic retinopathy following ophthalmological procedures. As a result, diabetics should be evaluated properly.
- A history of hypertension should be well-controlled in order to avoid any adverse incidence of expulsion hemorrhage.
- The history of recurring redness, discomfort, discharge, and past therapy must be inquired about in the ocular history.
- In terms of refractive error, the patient should be questioned at the age of 40 if they are ammetropic or emmetropic. The significance of this issue cannot be overstated:
  - Calculation of intraocular lens (IOL) power
  - Myopia causes a decrease in scleral stiffness. Delivery of the nucleus becomes more challenging in this situation.

Examination:

Slit-lamp examinations provide a wealth of information about a patient's condition [(9, 10, and 11)].

- Patients with poor endothelial cell counts, like glaucoma, Fuch's dystrophy, trauma, chronic iritis, multiple injuries, ageing or old keratitis can be excluded using specular reflection to assess the corneal endothelium in the eye. It's also important to examine for keratic precipitates.
- Slit-lamp examination of the iris of the pupil after dilation, the posterior synechiae, pigments on the lens, and the pupil should be inspected. It will

provide further information on the iris, as well as help determine whether or not the pupil dilates easily.

- By dilating one's pupil, it is easier to determine the hardness of one's cataract prior to cataract surgery
- If a fundus examination is not possible, a B scan can be used.
- SICS cannot be used on a hypotonic eye. As it becomes more difficult to make the scleral tunnel in an eye that is hypotonic, the tunnel may become ragged. Out of capsulotomies or capsulorhexis, the most significant component of SICS is to expose the nucleus in the anterior chamber of the eye. A hypotonic eye makes it harder to prolapse the nucleus in AC and express the nucleus. A pinky ball should not be used before a procedure, as a result. After a peribulbar injection, a light eye massage can be performed.
- Size and hardness of the nucleus increase as the patient ages. As we age, the lens gets 1/3rd larger than it was when we were younger. Consequently, SICS is not appropriate for people who are very old and have a hard and big nucleus. This is the most common procedure for patients who are quite young if we are performing SICS on an elderly patient, the incision should be larger than it is in younger patients.
- Capsulotomy and capsulorhexis are extremely difficult to perform on a small pupil. Because of this, anterior chamber prolapse becomes nearly impossible, and so ECCE is preferred to SICS.
- For non-phaco SICS, hypotony is a problem in patients who have had glaucoma surgery.
- Endothelial dystrophy of Fuchs There is a non-inflammatory loss of endothelium on both sides in this condition. When manipulating the AC, endothelial cell loss will be severe because the nucleus of SICS is prolapsed into the AC prior to its expression.

Operative considerations in mature senile cataract patients:

The mechanisms through which cataract surgery cause corneal endothelial cell loss and eventually leading to cornea edema include direct trauma of the cornea endothelium resulting from touching of the corneal endothelium during surgery by instruments [(12)]. Instruments cause a direct damage to the corneal endothelium leading to a reduction in corneal endothelial cells due to the fact that when the corneal endothelium is damaged it does not regenerate but just heals by sliding of the endothelial cells to fill the gap left by the damaged cells [(13)].

Insertion of intraocular lenses (IOL) is another mechanism through which corneal endothelial cell loss can occur during cataract surgery where by the IOL can accidentally touch the endothelium [(12)]. Due to the strong adhesive force between the methacrylate lens and the endothelial cell membrane, they stick together when they come in contact with one another; the separation of these two surfaces causes the cell membrane to be torn from endothelial cells resulting into the damage of the corneal endothelial cells. However, a study on reduction in endothelial cell density following cataract extraction and intraocular lens implantation showed that the major cause of endothelial cell loss is operative trauma to the endothelium whereby cataract extraction with lens implantation but without endothelial contact does not result in a significant corneal endothelial cell reduction than the cataract extraction alone [(14)].

When different types of intraocular lens are compared, studies have shown the implantation of an anterior chamber lens to be more traumatic than that of a posterior chamber lens [(15)]. But, this has been reduced by the modification of available implants and surgical techniques to an acceptable level of surgical risk.

IOL Choice:

Following cataract surgery, patients can choose from a variety of intraocular lenses (IOLs). The design, shape, and size of an IOL, as well as the type of material it is made of, all go towards determining its type (overall length and diameter of optic). Polymethyl methacrylate (PMMA), silicone, acrylic, or collamer can be used to make optics. PMMA, polypropylene, polyamide, or polyvinyl difluride are some of the materials used in haptics. It is possible to describe the optic design as spherical, aspherical or toric, and to further describe it as monofocal or multifocal. Haptic design options include one- or two-piece, open or closed, and foot plate designs for the haptics [(16, 17)].

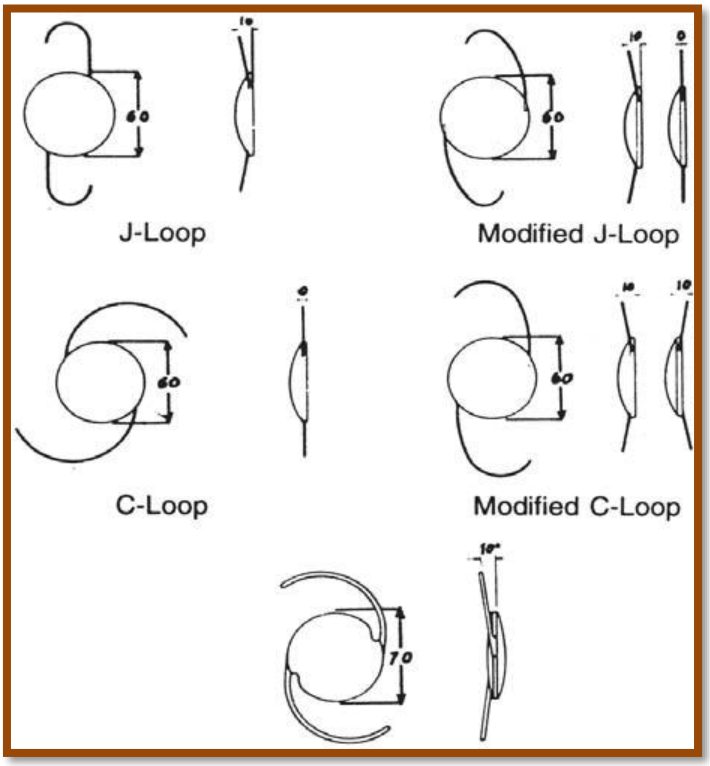

Figure (3): The most commonly utilized posterior chamber IOls are seen in this diagram.

Non-foldable IOLs with a 6.5 mm optic and a 13 mm overall diameter are commonly used for SICS surgery in underdeveloped nations due of their inexpensive cost.

Children are also implanted with PMMA IOLs because of their established long-term durability. While foldable IOL biomaterials such as silicone, acrylics, and hydrophobic polymers have been widely adopted by surgeons in the industrialized world and selected developing countries of the world, PMMA nevertheless remains widely used in many regions. Glistenings, microscopic vacuoles that form in the optic of a PMMA IOL, are extremely rare [17]. There is no need to change how foldable intraocular lenses (IOLs) are injected. However, because the lesion is so big, the chamber may collapse and increase the risk of posterior capsular rupture while injecting IOL. Because of the risk of iris contact and chaffing with single-pieced IOLs with square edge-haptics in SICS, it is best to avoid using them. Foldable IOLs can be implanted manually without loading them, or they can be injected in the conventional fashion, ideally with cohesive viscoelastics, in the same way that a rigid IOL is inserted [18].

In phaco surgery, acrylic IOLs have taken the position of silicon-plate IOLs. IOLs with acrylic hydrophobic coatings are less iris-friendly, but they are favoured by diabetes patients because they are less likely to cause postoperative inflammation and aqueous flare. Acryl hydrophobic IOLs have a lower risk of posterior capsular opacification and better mechanical stability than glass hydrophobic IOLs. Having a low water content, the hydrophobic IOL implanted during surgery resists capsular contraction, keeping its location and stability within the capsular bag practically constant [19].

Site of IOL implantation:

The preferred location of IOL implantation during cataract surgery is inside the bag of the lens, resting on the intact posterior capsule. An IOL haptic can be placed in the ciliary sulcus if the cataract is hard or calcified, or if the posterior capsule has dehiscence. Choosing a longer multipiece IOL (13.5 mm) can help ensure proper positioning. The sulcus should not be used for a single-piece IOL [18].

CONCLUSION

Corneal endothelial cells are sensitive to trauma, which affects cell density and cell morphology. Endothelial cell loss during surgery affects the ability of the cornea to preserve transparency with subsequent visual affection.

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