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RESEARCH ARTICLE

OPHTHALMIC VISCOSURGICAL DEVICES

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Abstract

Ophthalmic viscoelastic devices (OVDs) are recently used in cataract surgery and have expressivelyupgraded the safety and effectiveness of this surgical procedure. OVDs create and maintain anterior chamber depth and visibility, protecting the corneal endothelium and other intraocular tissues during surgery. The selection of the most adequate OVD is especially relevant when performing cataract surgery in challenging cases, such as in hard, mature cataracts, flat anterior chamber, pseudoexfoliation syndrome, intraoperative floppy iris syndrome, or glaucoma surgery. In such cases, OVD is crucial for facilitating the surgical procedure and the associated minimal complication rate. The use of a combination of OVDs (soft-shell technique and modifications), the use of blue-colored. OVDs, and the combination of sodium hyaluronate with lidocaine have also been described as useful tools in some of these challenging cases.

Introduction:-

Modern cataract extraction generally provides excellent visual outcomes. However, poor anterior capsular visualization can be a recipe for complication. In addition, failure to provide adequate tissue stabilization, space maintenance and protection of intraocular structures can lead to undesirable results like radialized anterior capsular tears, Descemet detachments, and corneal endothelial cell loss[1]. Since Healon (sodium hyaluronate 1%) was first introduced in 1979, an ever-growing number of OVDs have arrived with varying composition and rheologic behavior[2]. Ophthalmic viscosurgical devices (OVDs) are routinely employed by all modern-day cataract surgeons to protect intraocular structures[1].

The term viscosurgery was introduced almost 30 years[2] and recently Arshinoffcoined the new phrase 'ophthalmic viscosurgical device' (OVD)[3]. Viscoelastics are also known as ophthalmic viscosurgical devices[4]. The OVD has been used widely to maintain the intraocular space during the implantation of intraocular lenses;however, OVDs have been used as surgical devices on miscellaneous occasions. The ideal OVD remains in theeye during the procedure and can be removed easily atthe end of surgery to eliminate increases in intraocularpressure (IOP)[5]. Sodium hyaluronate was the first viscoelastic introduced in 1972 and was patented by Swedish Pharmacia as Healon in 1980. The term viscosurgery was introduced by Dr. Endre A Balazs 30 years back, which denotes the procedures and manipulations performed using OVDs. New products have been introduced recently and theircharacteristics have been evaluated[6]. In addition, theuse of OVDs in several complicated cases made thesurgeries easier and safer[1].

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Classification of OVD:
The classical classification of OVDs into cohesive and dispersive describes the intraoperative behavior of the various OVDs due to their rheological properties[7]. This classification was updated considering the analysis of zero-shear viscosity and the cohesion-dispersion index (CDI)[8]. According to this, OVDs are currently classified into three broad categories (Table1): cohesive (CDI C 30%asp/mmHg), dispersive (CDI\30%asp/mmHg), viscoadaptives[9].

S. No	Type	Examples	Properties	Advantages	Disadvantages
1.	**Cohesives (Higher viscosity)**	Hyaluronic acid	High molecular weight, High viscosity, High pseudoplasticity, High surface tension and Less coatability	Help to create space Induce and sustain pressure	Greater tendency to escape Less corneal endothelial protection If left in the anterior chamber can cause secondary glaucoma
2	**Dispersives (Lower viscosity)**	Hyaluronic acid Chondroitin sulfate Hydroxypropylmethylcellulose	Prolonged retention time, create partition spaces	Lesser tendency to escape from the anterior chamber, better protection of intraocular structures Protect cornea in Fuchs' endothelial dystrophy patients	It is aspirated in small fragments creating an irregular viscoelastic-aqueous interface that partially obscures the view Difficult to remove
3	**Viscoadaptives**	Hyaluronic acid	Act as cohesives under low shear stress Also called pseudo-dispersive	Ultra-viscous cohesive (solids)	Under high fluid flow, they easily fracture, freeing pieces to float Retained in the anterior segment similar to dispersive OVDs

Table 1:- OVDs are classified into three broad categories.

Rheological Properties of OVDs
OVDs are transparent, gel-like substances that have viscous and elastic properties.[10]

There are essentially four different properties to mention when discussing OVDs[11]:

Elasticity:
The tendency of a viscoelastic to go back to its original shape after it is deformed or stretched[12].

Viscosity, or resistance to flow, is primarily determined by the molecular weight and concentration, so that the higher the viscosity, the better the OVD at displacing tissue and staying in place[13,14].

Pseudoplasticity;
The ability of a viscoelastic to transform under pressure from a gel to a liquid substance. This property enables easy injection and removal of an agent at increasing flow rates[10].

Cohesiveness/dispersivenessor whether the agent adheres to itself or to surrounding tissues[15].

Viscosity, elasticity, and cohesion are important OVD physical properties, which alter retention and removal properties and may affect the surgeon's choice of OVD[7].

Indications of OVDs:

Cataract Surgery

Cataract surgery is facilitated by ophthalmic viscosurgical devices (OVDs)[16].

Viscoelastics form an essential component for every step of all types of cataract surgery, whether it is phacoemulsification, manual small incision cataract surgery (MSICS), extracapsular cataract extraction (ECCE), or intracapsular cataract extraction (ICCE). Viscoelastics assist in capsulorhexis, hydrodissection, nucleus prolapse and manipulation, trenching and emulsification of nucleus, IOL implantation, and they also coat the endothelium and prevent corneal damage. The primary function of OVDs is to form the anterior chamber by replacing aqueous humor.

Auffart et al reported that ophthalmic viscosurgical device (OVD) is used during intraocular surgery to protect ocular tissue. Afer the intraocular lens (IOL) is implanted, the OVD must be removed completely from the eye as any remaining OVD can lead to postoperative complications, such as increased intraocular pressure (IOP), endothelial cell loss or refractive shifs. It requires complete removal from the eye by the end of surgery to avoid postoperative complications[17].

Soft-shell technique [3]

• The technique was given by Arshinoff (1999)(Figure1)

• Using dispersive and cohesive OVDs creates a smooth, flat layer of dispersive OVD adjacent to the corneal endothelium over a high-viscosity, cohesive OVD.

• This technique is effective in reducing corneal endothelial cell loss after phacoemulsification surgery, especially in eyes with dense nuclear opacity, when compared with results using a single cohesive or dispersive OVD only.

Ultimate soft shell technique [18]

• Arshinoffl (1999) has developed a new technique called the ultimate soft-shell technique. Arshinoff recently proposed the ultimate soft shell technique. He exploited the rheology of viscoadaptive OVDs, suggesting the combined use of balanced saline solution (BSS) as an extremely low viscosity agent and a viscoadaptive OVD as the high viscosity component

• This technique compartmentalizes the anterior chamber using the ultimate low-viscosity fluid (balanced salt solution or trypan blue) underneath viscoadaptive OVDs with which the anterior chamber is filled to the desired extent (for capsulorhexis, 60%–80%; for capsular staining, 90%; for IOL implantation, 60%).

• The technique reduces the resistance to advancing the capsulorhexis with a needle or forceps while maintaining tamponade to the lens surface well, and also reduces the amount of dye required for capsular staining of mature or white cataracts[18].

Viscoanaesthesia

With the introduction of topical anesthesia in cataract surgery, many authors feel the need for an extra anesthetic effect during surgery, to reduce patient discomfort during phacoemulsification, iris manipulation, and IOL implantation[6]. This effect can be achieved by intracameral injection of lidocaine, as introduced by Gills et al. almost 8 years ago[19].

Tognetto et al concluded that viscoanesthesia really does represent a crucial innovation in cataract surgery, and it seems to be very promising. Effective anesthesia with limited side effects is what every surgeon needs and comfort is what patients expect. Time and the more widespread use of the new technique will prove the effectiveness of viscoanethesia[6].

Glaucoma Surgeries

In trabeculectomy, hyaluronic acid is the viscoelastic of choice. It helps to prevent endothelial trauma maintain the anterior chamber depth. Some surgeons leave viscoelastic in the anterior chamber to prevent postoperative hypotony and retino-choroidal folds. Viscoelastic can also be injected subconjunctivally for bleb formation.

In viscocanalostomy surgery, viscoelastic is used to open the Schlemm canal. Hyaluronic acid containing viscoelastics is used for viscocanalostomy as they have high pseudo-plasticity and high viscosity. Due to these properties, the viscoelastic can be injected into the Schlemm canal through a small needle, and they help maintain the space[20].

Korber at al Evaluated the surgical treatment of open angle glaucoma depends on values, such as target pressure, success rates and complication rates. Canaloplasty is a new non-penetrating method for glaucoma surgery.During the dilation they injectedmicrovolumes of a high viscosity ophthalmic viscosurgical device (OVD) (sodium hyaluronate)[21].

Viscomydriasis
Viscoelastic specially cohesives help to dilate the pupil during the surgery. In small pupil cases, it helps in viscomydriasis[22].

Corneal Surgeries
In penetrating keratoplasty, the viscoelastic helps maintain the anterior chamber before trephination, provides good support for perfect trephination, helps in the protection of intraocular structures, tamponade the vitreous, and coat the corneal donor button while suturing to prevent endothelial damage. Viscoelastics also play a significant role in deep anterior lamellar keratoplasty (DALK) for layer by layer removal of the host cornea and for exposing the Descemet membrane (DM) during surgery. In Descemet stripping, endothelial keratoplasty (DSEK) and Descemet membrane endothelial keratoplasty (DMEK) viscoelastic help perform DM scoring and any anterior chamber maneuvers. In femtosecond laser application of cornea, viscoelastics help to protect the corneal endothelium[10].

Retinal Surgery
The membranous adhesions during retinal surgery can be safely separated and excised with the help of viscoelastics. It also helps to release the traction. Sodium hyaluronate is one of the most commonly used viscoelastic during retinal surgeries[23].

Intraoperative Floppy Iris Syndrome (IFIS)
In 2005, Chang and Campbell first described the intraoperative floppy iris syndrome (IFIS) in patients with benign prostatic hyperplasia and systemic administration of alpha-A1 adrenoceptor antagonist tamsulosin[24]. This condition is characterized by a loss of the iris muscle tone leading to significant pupil constriction despite pupil dilatation with standard mydriaticdrugs before the initiation of cataract surgery.drugs before the initiation of cataract surgery.

Intraoperative Floppy Iris Syndrome (IFIS) is a known complication in patients treated for prostatic hyperplasia with alpha-adrenergic blockers. Viscoadaptiveviscoelastics are helpful in such a scenario to dilate and stabilize the pupil. This also helps to prevent iris prolapse[25].

Orbit and Oculoplasty Surgery
Congenital Nasolacrimal Duct Obstruction (CNLDO)-
Viscoelastic helps pass the probe through the NLD and keeps the NLD patent[26].

Pediatric Ophthalmology and Strabismus Surgery
In pediatric cataract, viscoelastic help in all the routine steps of cataract surgery. In strabismus, surgery helps in suture adjustment with less force, helps to coat the muscle, and decreases scar formation in the muscular tissues[27].

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