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Anesthesia in Clinical Ophthalmology

ANESTHESIA
in Clinical Ophthalmology

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Preface

Anesthetic management plays an important role in the successful outcome of operations on the eye. Because of the comparatively small area of surgical endeavor and the anatomic isolation of the eye and its appendages, it is possible to carry out most ophthalmic operations under local anesthesia. In 1884 Carl Koller first demonstrated the practicability of producing local anesthesia of the eye. He dropped cocaine into a frog's eye, which became insensitive to pain. He then confirmed this action on himself and in clinical practice. During the past decade new, safer, more potent and more reliable anesthetic agents have significantly improved the results of established local techniques.

There have also been notable changes in the applications of general anesthesia in ophthalmology. The increasing numbers of qualified anesthesiologists, and the advances made in the techniques of general anesthesia, are leading to a wider acceptance of these procedures in ophthalmic surgery. The gradual introduction of general anesthetic agents with more specific actions permits improved control of operating conditions and increased safety. Ophthalmic surgery, in its turn, has been reaping the benefits of this progress. The degree of control now achieved by anesthesiologists enables the ophthalmologist to perform any operation under general anesthesia with comparative safety.

During intraocular procedures it is particularly important to keep the intraocular pressure as low as possible to prevent loss of ocular contents. Therefore, an understanding of the physiology of intraocular pressure and the influence of anesthesia and surgical intervention on it is essential as a basis for planning effective anesthetic techniques.

The aim of this monograph is to discuss the various anesthetic techniques available and their application to ophthalmic surgery, and to provide a rational basis for their use.

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Glossary

Akinesia. Paralysis of the extraocular and orbicularis muscles.

Anticholinesterase. Drug which inhibits the activity of cholinesterases.

Aphakia. Absence of the lens.

Aqueous humor. Fluid secreted by the ciliary epithelium and filling the posterior and anterior chambers of the eye. The word **aqueous** alone is often used elliptically.

Arterial circle of Zinn. Circle formed by branches of the short posterior ciliary arteries, which supplies the intrabulbar portion of the optic nerve.

Assisted respirations. Augmentation of inadequate spontaneous respiratory activity by intermittent manual or mechanical inflation of the lungs.

Ayre's "T" piece. Valveless method of administering anesthetic gases *via* one arm of a "T" shaped connection, the other arm of which allows expired gases to escape freely.

Basal iridectomy. Excision of a portion of the base of the iris.

Bullous keratitis. Disturbance of the cornea characterized by corneal edema and the formation of vesicles in the corneal epithelium.

Canthotomy. Incision at the junction of the upper and lower lids, permitting the eyelids to open wider.

Canthus. Junction of the upper and lower lids. **Internal c,** inner, nasal c. **External c,** outer, lateral c.

Carbonic anhydrase. Enzyme present in red blood cells and other tissues which catalyzes the conversion of carbon dioxide (CO_2) into carbonic acid (H_2CO_3).

Cataract. Opacification of the crystalline lens.

Chalazion. Infection of a Meibomian gland in the eyelid.

Choriocapillaris. Capillary portion of the vascular network of the choroid.

Complete iridectomy. Excision of a segment of the iris extending from the base to the pupillary margin.

Conjunctiva. Transparent mucous membrane covering the sclera and the inner surface of the eyelids.

Controlled respirations. Maintenance of adequate alveolar ventilation by intermittent inflation of the lungs, in the absence of spontaneous respiratory activity, by intermittent manual or mechanical inflation of the lungs.

Cornea. Transparent tissue composing the anterior surface of the eye, overlying the iris and pupil (see fig. 1, p. 26).

Corneoscleral sutures. Sutures placed across the lips of a surgical wound at the limbus.

Corneoscleral trephining. Filtering operation for glaucoma, in which a 1½- to 2-mm. round opening is made at the limbus under a flap of conjunctiva.

Cyclodialysis. Internal filtering operation for glaucoma, in which the ciliary body and base of the iris are separated from the sclera in one segment of the eye.

Cyclodiathermy. Electrocoagulation of a portion of the ciliary body.

Cycloplegic. Drug which paralyzes the ciliary body, resulting in a paralysis of accommodation.

Cytochrome oxidase. Enzyme necessary, in the oxidation of metabolites, for the reoxidation of cytochrome *c* after its reduction by dehydrogenases, at the time of the union of hydrogen with molecular oxygen.

Dacryocystectomy. Excision of the lacrimal sac.

Dacryocystorhinostomy. Creation of an opening between the lacrimal sac and the nasal cavity.

Endophthalmitis. Inflammation involving the contents of the eye.

Enucleation. Removal of the eyeball.

Epiphora. Tearing.

Erisephake. Suction device used to grasp the lens in cataract surgery.

Evisceration. Removal of the contents of the eye, leaving only the scleral shell.

Extracapsular cataract extraction. Removal of a cataractous lens after rupturing the lens capsule.

Facility of aqueous outflow. Ease with which aqueous escapes from the eye; usually expressed as a coefficient of aqueous outflow, it is, in essence, the reciprocal of the resistance to aqueous outflow.

Fasciculations. Muscular twitching occurring after the administration of depolarizing muscle relaxants.

Glaucoma. Disease characterized by pathologic elevation of the intraocular pressure.

Graefe knife. Knife used for incision of the eye in intraocular surgery.

Hyaluronidase. Enzyme present in certain tissues which reduces vis-

cosity and thus permits greater spreading of materials in the tissue spaces.

Hydroxydione sodium succinate. Viadril. A steroid with anesthetic properties.

Intermittent positive pressure respirations. Controlled or assisted respirations by intermittent inflation of the lungs.

Intracapsular cataract extraction. Removal of a cataractous lens with its capsule intact.

Iridencleisis. Filtering operation in which a piece of iris is incarcerated in the scleral wound under a conjunctival flap.

Iridocyclitis. Inflammation of the iris and ciliary body.

Iris bombé. Bulging forward of the iris caused by a complete obstruction of the pupillary aperture by posterior synechiae to the lens of vitreous face.

Keratome. Triangular knife used in incision of the eye.

Keratoplasty. Corneal transplantation.

Limbus. Junction of the cornea and sclera.

Macintosh laryngoscope. Laryngoscope with a curved blade.

Magill forceps. Forceps used to hold an endotracheal tube to facilitate its introduction into the trachea.

Miotic. Drug which constricts the pupil.

Muscle cone. The four ocular rectus muscles and their enclosed space behind the eyeball.

Mydriatic. Drug which dilates the pupil.

Negative phase. Creation of subatmospheric pressure in the respiratory tract, in the interval between inspiratory cycles.

Nonrebreathing system. Method of administering fresh anesthetic gases during each inspiratory cycle.

Opticokinetic nystagmus. Railroad nystagmus. Nystagmoid movements of the eyes caused by watching objects moving in front of the eyes. Actually a series of changes in fixation mediated by a reflex pathway involving the visual cortex, the cerebellum, the vestibular nuclei and the nuclei to the extraocular muscles.

Orbit. Bony enclosure containing the eye and its associate structures.

Peripheral iridectomy. Removal of a portion of the iris in its periphery, leaving the sphincter and pupillary border intact.

Plasma cholinesterase. Pseudocholinesterase. Nonspecific cholinesterase. Enzyme synthesized in the liver and present in plasma, which hydrolyzes acetylcholine, succinylcholine, several other choline esters and ester type local anesthetic agents, and which is not inhibited by excess of substrate.

Photocoagulation. Production of a destructive lesion by focusing an intense spot of light on the area to be treated.

Reservoir bag. Rubber bag from which anesthetic gases are inhaled.

Retinal detachment. Separation of the bulk of the retina from the pigment epithelium of the retina.

Semiclosed system. Method of administering anesthetic gases during which some rebreathing of expired gases (from which carbon dioxide has been removed with soda lime) is permitted.

Staphyloma. Bulging of the sclera, cornea, or limbus due to localized tissue weakness.

Synechiae. Adhesions of the iris to adjacent structure.

Tenon's capsule. Synovial-like membranous capsule surrounding the posterior two-thirds of the eyeball.

Tonometry. Measurement of the intraocular pressure.

True Cholinesterase. Acetylcholinesterase. Specific cholinesterase. Enzyme present mainly in red cells, muscle, nerve fibers and the brain, which hydrolyzes acetylcholine, acetyl-β-methylcholine, and most of the choline esters hydrolyzed by plasma cholinesterase, does not hydrolyze succinylcholine, and is inhibited by excess of substrate.

Uveal tract. The choroid, ciliary body and iris.

Vitreous humor. Vitreous. Semifluid, transparent substance which lies between the retina and lens.

Zonule of Zinn. Delicate ligament supporting the lens and originating in the ciliary body.

Zonulysis. Dissolution of the zonule of Zinn by enzymatic means.

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CHAPTER 1

Physiology of Intraocular Pressure

No phase of the physiology of the eye has received more attention in ophthalmic literature and research than the investigation of intraocular pressure; at the same time no phase has been the subject of more misconceptions on the part of physicians in other branches of medicine.

Effects of Increased Intraocular Pressure

Whether done under local or general anesthesia, complication free intraocular surgery demands nearly perfect control of the intraocular tension. When an eye is to be opened the intraocular pressure should be as low as possible. If the pressure is high at the time of the incision, the intraocular contents, *i.e.*, the iris, lens, vitreous and retina, may be expelled through the wound with the sudden loss of pressure. Sudden release of intraocular tension also predisposes to the rupture of a sclerotic short posterior ciliary artery in the choroid, which in turn may create an expulsive hemorrhage. A massive choroidal hemorrhage may lift up the choroid and force the vitreous, iris, retina and lens out of the eye and cause loss of vision. Once the eye has been incised, the intraocular pressure becomes atmospheric; from then on volume

displacement within the eye becomes the essential problem. When the eye is open, external pressure on the eye or vascular congestion of the uveal tract will displace the iris, lens, vitreous and retina in the direction of the incision. If the pressure change is of sufficient magnitude, some portion of these structures may prolapse through the wound.

Increased tension or contraction of the orbicularis and extraocular muscles, the touch of the surgeon's instruments and hands, or venous congestion may increase the intraocular pressure.

Ophthalmic surgeons are most concerned in avoiding loss of vitreous because this complication, if it does not cause immediate blindness, can produce severe visual impairment, blindness, or even loss of the globe through subsequent development of bullous keratitis, aphakic glaucoma, or retinal detachment.

A normal or glaucomatous eye which is not to be opened can withstand moderate, temporary elevations of tension without ill effects. Therefore, many of the factors to be discussed are not necessarily critical in extraocular surgery. It is hoped that the following discussion will put the whole subject in its proper perspective and provide the basis for the rational use of anesthesia in ophthalmology.

The eye normally performs all its functions at a pressure about 15 to 25 mm. Hg above atmospheric pressure, higher than any other organ in the body. The apparent physiologic functions of this increased pressure includes the maintenance of the globular shape of the eye, the maintenance of the optical properties of the cornea (by assuring the proper alignment and hydration of the corneal stromal fibers) and the maintenance of an even and constant curvature of the corneal surface. Corneal opacification may occur during periods of abnormally high pressure, as in glaucoma, or during periods of ocular hypotony associated with surgery or iridocyclitis. In either case the proper alignment of the stromal fibers is disturbed and the cornea may become cloudy before or even without edema formation. If an abnormally high or low tension persists for any length of time, disturbance of the metabolism of the endothelial and epithelial cells usually follows and true corneal edema develops.

Components of Intraocular Pressure

Several factors contribute to the maintenance of the intraocular pressure. These include scleral rigidity, the lens, vitreous and aqueous humors, and blood pressure.

Scleral Rigidity

The sclera forms a relatively inelastic coat and maintains the volume of the eye relatively constant. Thus an increase in the volume of any of the components of the intraocular contents, unless counteracted by a corresponding decrease in the volume of another component, is reflected in an increase of the intraocular pressure. Infants' eyes, and to a lesser degree myopic eyes, have a somewhat less rigid sclera which can "take up" some volume increase by permitting the eye a degree of distension. From a clinical standpoint, scleral rigidity affects the accuracy of tonometric readings and must be taken into account when outside the normal range.

Lens

The lens contributes significantly to the volume of the eye. Under normal circumstances the lens grows slowly in size throughout life. This increase in the volume of the lens is compensated for by a corresponding decrease in the volume of the fluids of the eye. Consequently there is no major change in the intraocular pressure during life. Under pathologic circumstances, such as are encountered with intumescent cataract formation, the lens may swell rapidly; its increase in size can not be compensated for by displacement of fluids, and an acute rise in intraocular tension will ensue. In most of these cases surgical removal of the swollen lens is necessary for the restoration of normal intraocular pressure.

Vitreous Humor

The vitreous is basically an unstable gel with a fine fibrillar supporting structure. Under unfavorable circumstances such as trauma, intraocular inflammation, aging or severe myopia, it has a marked tendency to assume a fluid state. Since the unbound