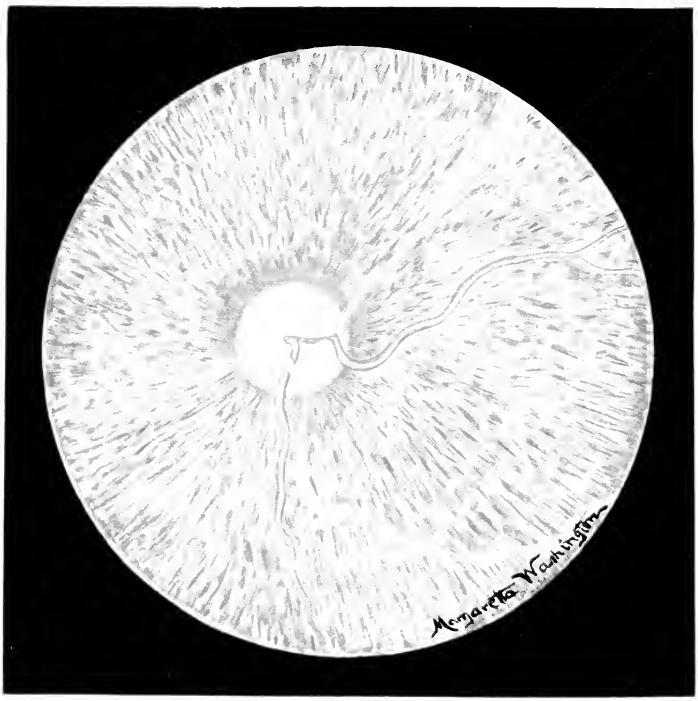


NORMAL FUNDUS OF A DOG'S LEFT EYE.

# OPHTHALMOLOGY

*for*

# VETERINARIANS

BY

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DEDICATED TO THE MEMORY OF MY SON

WILFRED EMERSON SHARP

WHO DEPARTED THIS LIFE

SEPTEMBER 10, 1904

IN HIS EIGHTEENTH YEAR

# PREFACE

THIS small volume is the fulfilment of a wish often expressed by the students of the Indiana Veterinary College. It comprises, with the exception of dissections and clinical demonstrations, the work with the senior class in this department during the term.

As external diseases of the eye are principally seen in animals, more attention has been given such diseases in as plain and few words as is consistent with the subject, so that they may be comprehended by the student as well as by the practitioner.

I am indebted to Drs. G. H. Robberts, W. B. Craige, and other members of the Indiana Veterinary College for valuable assistance, and to Drs. G. E. deSchweinitz, Alexander Duane, Wm. C. Posey, and other authors of works on ophthalmology for valuable information.

As the literature upon diseases of the eye in animals is extremely limited, I have been obliged to draw largely from "Law's Veterinary Medicine," especially on the subject of parasites of the eye.

WALTER N. SHARP.

INDIANAPOLIS, INDIANA,
*March*, 1913.

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# OPHTHALMOLOGY FOR VETERINARIANS

## CHAPTER I

### ANATOMY OF THE EYE

"From a point of view of comparative anatomy, an eye is any part of an animal body which responds more readily than other parts to the special stimulus of light, or whose activity is specially excited by the impact of light rays."—*Century Dictionary.*

In the low forms of life the eye-spots or eye-points, as they are called, differ greatly in number. They are rudimentary eyes, and consist in many cases of simple pigment spots sensitive to light, and may be situated anywhere on the body.

In insects proper, crustaceans and arachnidians, the eyes are well developed and are either simple or compound. They are usually two in number, but may be four, six, or eight. Crustaceans, as a rule, have a single pair, which stand out from the head like a cherry upon a stem.

In describing the anatomy of the eye, that of the highest order of the animal kingdom will be consid-

ered. The higher in the scale of animal life, the more nearly is the eye like that of man; the only difference is the addition of some conveniences of which man is not in need. Most of the quadrupeds, for instance, are supplied with a third eyelid, or nictitans membrane, and a retractor muscle. The former acts as a

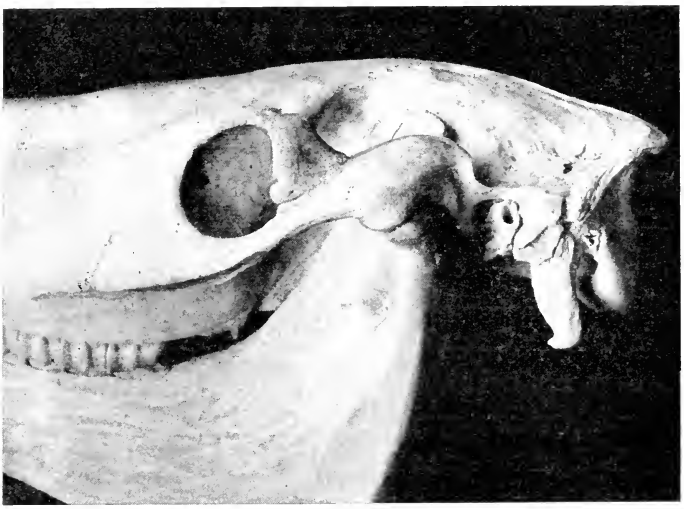

Fig. 1.—Portion of skull of horse, showing bony orbit.

finger to remove foreign bodies, dust, etc., that may fall upon the cornea. The latter serves to draw the eyeball backward into the orbit and protect it from approaching harm. These, together with the variations in size, are the only practical differences from the human eye.

The eyes of quadrupeds present nearly laterally,

and are protected by bony orbits and soft appendages. They are embedded in a cushion of fat and surrounded

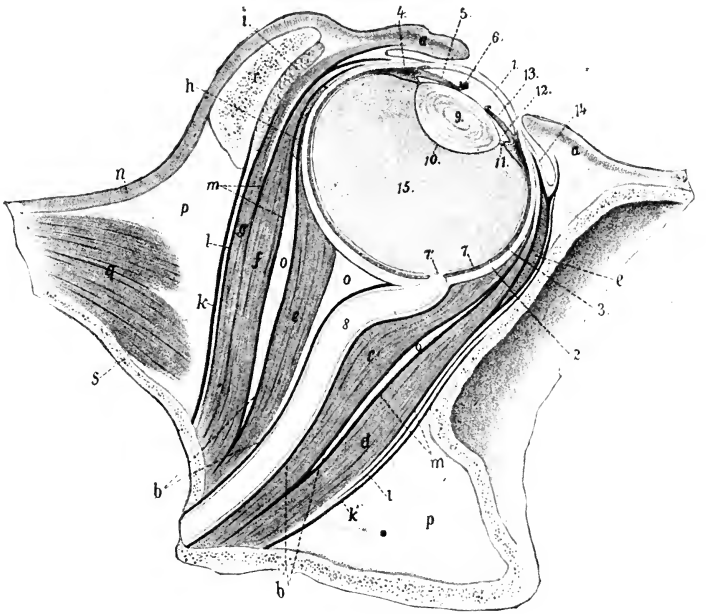


Fig. 2.—Vertical axial section of orbit of horse: *a*, *a*, Eyelids; *b*, bulbar fascia (Tenon's capsule); *c*, *c'*, retractor bulbi; *d*, rectus oculi inferior; *e*, obliquus oculi inferior (in cross-section); *f*, rectus oculi superior; *g*, levator palpebræ superioris; *h*, obliquus oculi superior (in cross-section); *i*, lacrimal gland; *k*, *k'*, periorbita; *l*, superficial fascia; *m*, deep fascia; *n*, skin; *o*, retrobulbar fat; *p*, extra-orbital fat; *q*, temporalis muscle; *r*, supra-orbital process; *s*, cranial wall; *1*, cornea; *2*, sclera; *3*, choroidea; *4*, ciliary muscle; *5*, iris; *6*, granula iridis; *7*, retina; *7'*, optic papilla; *8*, optic nerve; *9*, crystalline lens; *10*, capsule of lens; *11*, ciliary zone; *12*, posterior chamber; *13*, anterior chamber; *14*, conjunctiva bulbi; *15*, vitreous body. (After Ellenberger, in Leisering's Atlas.)

or, rather, encased within a capsule, in which they are freely moved at will by the aid of the extrinsic muscles.

The **coats** of the posterior five-sixths of the globe are three in number, and from without inward are called the sclera, the chorioid, and the retina. The anterior one-sixth is formed by the transparent cornea.

The eye **internally** is composed of the anterior chamber, the iris and ciliary body, the posterior chamber, the lens in its capsule suspended by the ciliary ligament from the ciliary muscle, the vitreous encased in the hyaloid membrane, and the optic disk.

The **sclera** is a white, tough, fibrous membrane, and extends from the optic nerve to the cornea. It is really an expansion of the dura mater, which extends forward from the skull cavity through the optic foramen in the apex of the orbit, and serves, in its course to the eyeball, as a sheath for the optic nerve. It is principally for protection, and affords attachment for the extrinsic muscles. The four recti and the two oblique muscles have their attachment anterior to the equator, while the retractor muscle is widely expanded over the posterior third of the sclera, which is its thickest portion.

The fine fibrillæ of which the sclera is composed run in two principal directions—from before backward, and in a circular direction concentric with the corneal margin.

Anteriorly, the sclera is continuous with the true cornea. At the posterior portion a few fibers of the inner layer penetrate the optic nerve at a junction with the trunk of the nerve and its head, and are inserted into

the connective tissue about the central vessels. This portion is known as the lamina cribrosa. The deep layers of the sclera contain numerous pigment-cells, more pronounced in animals than in man, hence the brownish or bluish color. It is penetrated by numerous ciliary

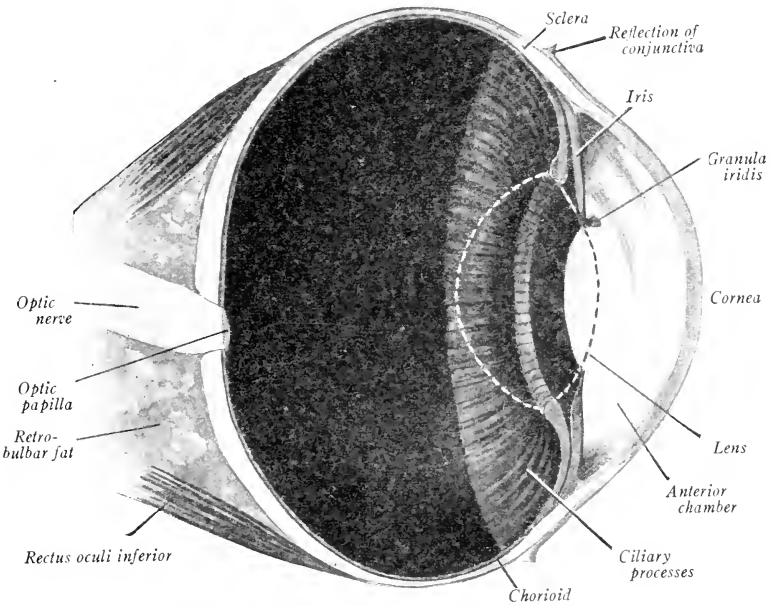


Fig. 3.—Vertical section of eyeball of horse, about $\frac{3}{2}$. The contour of the crystalline lens is dotted. (Sisson, Veterinary Anatomy.)

vessels at the posterior portion surrounding the optic nerve entrance. The anterior portion is connected to the conjunctiva by a loose connective tissue, known as the episcleral tissue.

The **chorioid,** or middle coat, is a vascular and pig-

mentary structure. Its function is to nourish the eye and absorb light. It extends from the optic disk to the ora serrata.

Histologically, the chorioid consists of five layers. First, from without inward, the suprachorioid, inti-

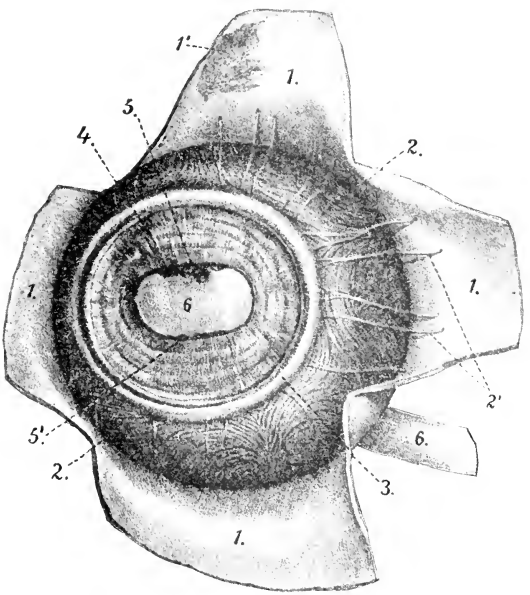


Fig. 4.—Vascular tunic of eyeball of horse, front view. The cornea is removed and the sclera is reflected in flaps: *1*, Sclera; *1'*, lamina fusca; *2*, choroidea; *2'*, ciliary veins; *3*, ciliary muscle; *4*, iris; *5*, *5'*, granula iridis; *6*, pupil, through which the lens is visible. (After Ellenberger, in Leisering's Atlas.)

mately connecting it with the sclera; second and third, are two layers of vessels, large and small respectively, embedded in a stroma of connective tissue with numerous branched pigment-cells; fourth, the lamina ruyschii,

composed principally of capillaries; fifth, the lamina vitrea, which is lined with a layer of pigment epithelium. Late authorities claim that this pigment-layer embryologically belongs to the retina. An absence of black pigment on the posterior layer in the carnivora affords a greenish-blue reflex, and is known as the

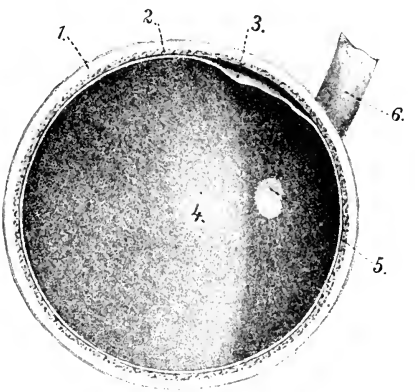


Fig. 5.—Fundus oculi, seen on equatorial section of eyeball of horse: *1*, Sclera; *2*, choroidea; *3*, retina (loosened); *4*, tapetum; *5*, optic papilla; *6*, optic nerve. (After Ellenberger, in Leisering's Atlas.)

"tapetum lucidum." This reflex is noticeable in cats' eyes in the dark.

Because of the intimate association of the pigment and circulatory layers of this body with those of the ciliary body and iris, and from the likeness, as a whole, to that of a grape when the sclera is stripped off, this portion of the eye—the iris, the ciliary body, and the chorioid—is known as the uveal tract or uvea.

The **retina** is the internal coat or lining of the eye.

It is composed principally of nerve elements and is practically an expansion of the optic nerve. Its function is to receive the image focused by the refractive media, which is conveyed through the optic nerve to the sight center in the occipital lobes. The retina of the living eye is transparent, while that of the dead eye is opaque. It also loses its transparency in portions undergoing pathologic changes.

It extends posteriorly from the optic nerve, and apparently terminates anteriorly at an irregular line, known as the ora serrata, posterior to the apex of the ciliary body, but "the microscope shows that under a similar form it extends still farther, even up to the edge of the pupil. It, therefore, lines the inner surface of the ciliary body and the posterior surface of the iris" (Fuchs).

Corresponding with the central vision at the posterior pole lies a small yellowish spot, called the macula lutea, a slight depression in the center of which is the fovea centralis.

Histologically, the retina is a very complicated structure, and consists from without inward of ten layers: 1, A pigment epithelial layer; 2, a layer of rods and cones; 3, an external limiting membrane; 4, an external molecular layer; 5, an external granular layer; 6, an internal molecular layer; 7, an internal granular layer; 8, a layer of granular cells; 9, a layer of nerve-fibers; 10, an internal limiting layer or membrane.

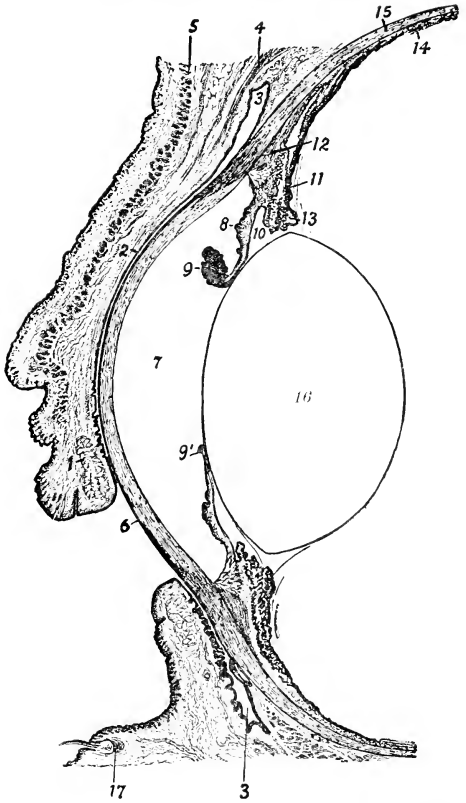


Fig. 6.—Vertical section of anterior part of eye of horse, with lids half closed: *1*, Tarsal gland of upper lid; *2*, palpebral conjunctiva; *3*, fornix conjunctivæ; *4*, levator palpebræ superioris; *5*, orbicularis oculi; *6*, cornea; *7*, anterior chamber; *8*, iris; *9*, *9'*, granula iridis; *10*, posterior chamber; *11*, ciliary process; *12*, ciliary muscle; *13*, ciliary zone or suspensory ligament of lens; *14*, chorioid; *15*, sclera; *16*, lens; *17*, root of tactile hair. (After Bayer, Augenheilkunde.)

The pigment epithelial layer is the one before mentioned with the chorioid, which really belongs to the retina. The rods and cones are unevenly distributed,

as the cones only exist in the fovea, while the rods become more abundant from the border of the macula lutea to the ora serrata, while the cones diminish.

The retinal vessels enter through the center of the optic nerve, expanding and dividing, much like the twigs of a tree, through the retinal tissue to the ora serrata without anastomosing. These afford nourishment to the inner layers, while the outer layers are dependent upon the small vessels of the inner layer of the chorioid for nourishment. The retinal vessels can be distinctly seen by the aid of the ophthalmoscope.

The **cornea** comprises about one-sixth of the external anterior portion of the eyeball. It is a perfectly transparent body, and one of the refractive media next in importance to the lens. The anterior surface is convex and the posterior is concave.

It is composed of five layers. From without inward, they are: The epithelial layer, Bowman's membrane, the stroma or cornea proper, Descemet's membrane, and the endothelium. The epithelium is composed of columna, polyhedral and squamous cells, and is continuous with the conjunctiva. Bowman's membrane is devoid of cells, and is described as an elastic homogeneous membrane. It is strongly adherent to the stroma. The stroma is the thickest layer, and consists of numerous fibrous layers enclosing corpuscles similar in structure closely connected by a cement substance. The corneal cells proper are fixed non-

motile cells, flat in appearance, and connected to neighboring cells by branched processes. A type of motile cell, said to be white blood-corpuscles, but few in number, float in the lymph-channels of the stroma. This portion of the cornea is continuous with the sclera. Descemet's membrane is an elastic homogeneous hyaloid membrane, and is easily separated from the stroma. It is said to be the protecting membrane of the posterior portion of the cornea because of its elasticity and resistance to pathologic processes. The endothelium or posterior epithelium, as it is sometimes called, lines the posterior portion of Descemet's membrane. It is composed of flattened cells of a single layer.

The cornea has no vessels of its own, but is nourished by a network of capillary loops near the border. These loops are supplied by the anterior ciliary vessels.

The **iris** is practically a diaphragm, much like the diaphragm in a camera, with an opening in the center called the pupil. It is a dividing membrane between the anterior and the posterior chambers, which are filled with a watery fluid known as the aqueous humor. The pupillary portion of the iris rides on the lens during contraction and dilatation. By reason of the convexity of the lens the iris is slightly pushed forward at this portion. Should the lens be absorbed, dislocated, or removed, the iris would be tremulous for want of support. This is known as iridodonesis.

The iris arises from the anterior portion of the

ciliary body also by a ligament of loose tissue from near the posterior portion of the sclerocorneal connection. This ligament is called the ligamentum pectinatum. It has nearly a semicircular shape, and comprises the angle between the sclerocorneal margin and the iris. It is the extreme boundary of the anterior chamber and a most important structure.

The iris is described as "a spongy sort of tissue," composed principally of numerous delicate blood-

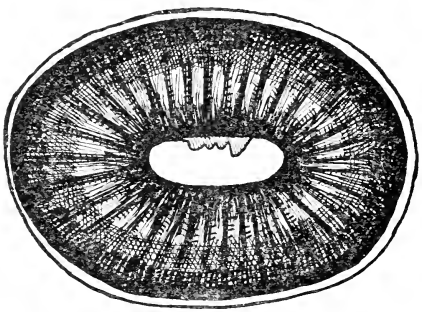

Fig. 7.—Iris of the horse, showing position of corpora nigra.

vessels, radiating from the periphery toward the pupil, and interspersed with a meshwork of branched and pigment-cells. The anterior surface is covered with epithelium (except the hollow spaces or crypts), which is continuous with that on the posterior cornea. The posterior surface is covered with a delicate membrane, upon which rests a layer of pigment epithelium. This membrane, with its fibers extending in a radial direction, constitutes the dilator pupillæ muscle. The

sphincter pupillæ is a circular, flat body, located in the stroma near the pupillary margin. This muscle contracts the pupil.

The posterior layer of pigment epithelium is continuous with that of the ciliary body and retina. It

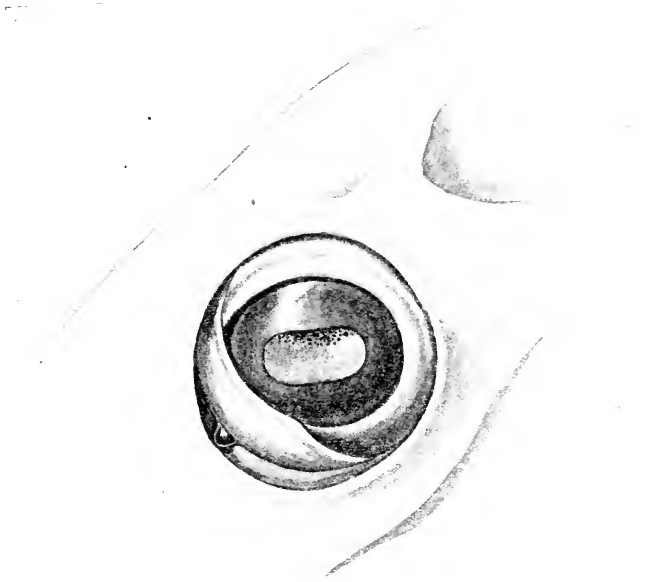

Fig. 8.—Eyeball of horse in orbit, showing shape of the iris and the corpora nigra.

extends to the anterior margin of the pupil, and in the horse it is quite thick in the upper portion, forming several prominent projections into the pupillary space. These pigment bodies are known as the "corpora nigra,"

and are commonly called "grape-kernels" and "soot-balls." The pigment of the posterior layer and that in the meshes of the stroma give color to the iris, and the varied colored irides depend upon the amount of pigment deposited in them. A horse with little or no pigment in the iris is called "wall eyed." Albinos are devoid of pigment. The white rabbit is a good example. In such cases a pinkish reflex is seen, derived from the retinal circulation.

The **pupil** varies in size and shape in different animals. In fetal life a delicate membrane covers the pupillary space, known as the membrana pupillaris. This disappears a few days or weeks before birth, though in some cases portions of it remain in threadlike forms, known as a persistent pupillary membrane, which is often mistaken for a pathologic condition.

The **ciliary body** is closely connected to the sclerotic coat from the ora serrata to a point near the sclerocorneal junction. It is composed of muscular fibers, connective tissue, blood-vessels, and pigment. The body is circular in shape in relation to the sclerocorneal margin. By making a vertical or horizontal section of the globe the muscle can be studied longitudinally. Such a section gives it a triangular appearance. The muscle-fibers are of two kinds—the longitudinal and the circular. The former comprise the greater portion, and lie externally near the scleral tissue, and are called Brücke's portion, after the discoverer. The latter form

the internal base of the muscle body and were discovered by Heinrich Müller; hence, it is called Müller's portion. At the anterior zone are folds of connective-tissue stroma—seventy or more in number—intermixed with numerous blood-vessels and branched pigment-cells. The anterior internal portion of the body is continuous with the iris.

A layer of pigmented and one of non-pigmented cells lines the body, and these are continuous with the posterior layers of the iris forward and the chorioid and retina backward. This intimate association of the pigment, from the optic disk to the pupillary border, has given it the name of the uvea.

The ciliary muscle is the muscle of accommodation, and by its contraction the lens becomes more convex, shortening its focus, and accommodating vision for near work. This and the sphincter and dilator pupillæ are the intrinsic muscles of the eyeball.

The **lens** is the principal refractive medium. It is biconvex, perfectly transparent, colorless, circular in shape, and is enclosed in a delicate transparent capsule. It lies between the iris and the vitreous, where it rests in a fossa in the latter substance—the fossa petellaris. The space between the border of the lens and the ciliary muscle is known as circumlental space. The anterior portion supports the pupillary border of the iris.

The lens is composed of hexagonal prisms, arranged in concentric layers supported by a cement substance.

The center or nucleus is unstriated and becomes sclerosed as age advances. It is supported by the suspensory ligament or zonule of Zinn. This ligament is composed of homogeneous fibers, which arise from the ciliary body anterior to the ora serrata and the ciliary processes, and it is fused with the lens capsule near the border. The space between the fibers as they diverge is called the canal of Petit, and is triangular in shape on transverse section. The capsule is similar in structure to the suspensory ligament. The anterior capsule has a layer of epithelial cells on the surface next the lens, which become associated with the lens substance near the zonular portion. The posterior capsule has no epithelium.

Like the cornea, the lens has no blood-vessels of its own. It derives its nourishment from the ciliary processes.

The **vitreous** is a gelatinous substance, perfectly transparent and colorless. It fills the vitreous chamber, or that portion of the globe posterior to the lens, and it is enclosed in a delicate structure called the hyaloid membrane. At the anterior portion is a depression in which rests the lens.

The vitreous mass is composed of rounded and branched cells. It is devoid of blood-vessels, and receives its nourishment from the uvea. In the center is a small canal which serves as a lymphatic channel. This, in fetal life, was traversed by the hyaloid artery

from the optic disk to the posterior lens capsule. In some cases portions of this persist, with an opacity of the central portion of the posterior capsule, known as a posterior polar cataract.

Should the vitreous become fluid, as it sometimes does by reason of disease, the tension of the globe is much decreased and the retina may become detached by loss of support.

The **conjunctiva** is a mucous membrane, and covers the anterior half of the globe, except that portion supplied by the cornea. It merges with the anterior epithelium of the cornea, extending over the sclera as far as the fornix, where it folds upon itself and lines the posterior surface of the lid, and is strongly adherent to the tarsus. This portion is called the palpebral conjunctiva. The bulbar portion is freely movable over the sclera, and is connected to it by the loose episcleral tissue. At the inner angle, in man, is a fold known as the plica semilunaris, which is said to be a rudimentary nictitans membrane so prominent in animals. Just inside of this is a small elevated island of tissue covered with hairs, known as the caruncle.

The **nictitans membrane,** or "accessory eyelid," is situated near the nasal angle, between the globe and the side of the orbit. It is composed of elastic fibrocartilage and is irregular in form, being thick and somewhat prismatic at its base and thin anteriorly, where it is covered with a fold of conjunctiva. Posteriorly, it is con-

tinuous with a pad of fat which is insinuated between all the muscles of the eye. Its internal surface is concave and its external surface is convex. When the eye is in its natural position only the margin of the membrane, covered by conjunctiva, is perceptible, the rest being buried in the ocular sheath; but when, by contraction of the straight muscles, the globe presses upon the pad of fat, the membrane is forced out and covers more or less of the cornea. This movement, which is instantaneous, is for the purpose of removing any offending agent from the surface of the eye. In some diseases, as tetanus, the membrane is forced outward and remains so. It is vulgarly called the "haw of the eye" (Vaughn).

The nictitans is very prominent in fowls and birds, as well as in quadrupeds generally, while in the inhabitants of the sea it is absent. Its function is associated with the "gland of Harder," which is a sort of supplementary lacrimal gland, and furnishes an abundance of unctuous fluid in conjunction with the action of the membrana nictitans. It is described as a "reddish-yellow gland," and is situated beneath the membrana nictitans, at about the middle of its outer portion.

As these organs are very essential for the protection of the cornea, they should by no means be interfered with surgically, as is too often done without sufficient reason.

# CHAPTER II

## SYSTEMATIC EXAMINATION OF THE EYE

The symptoms of pathologic conditions in animals' eyes are objective, and, in order to be able to distinguish them, one must be familiar with the normal conditions.

Examine normal eyes at every opportunity; observe the particular size and shape of the anterior portion in animals of different kinds; see that the lids, iris, conjunctiva, etc., are comparatively uniform in size, shape, color, and transparency. If one lid droops more than the other or is completely closed, it indicates a partial or complete paralysis of the muscle that elevates the lid —the levator palpebrarum. If the lid fails to cover the cornea when the lid is relaxed, the orbicularis palpebrarum is involved. Should the lid be closed and raised with much resistance, a spasm of the orbicularis exists, produced by the presence of a foreign body or from some other reflex cause. Examine the border of the lids to see that the lashes are properly directed, for if they turn inward they act the same as a foreign body. The puncta lacrimalia must lie in close apposition to the eyeball, otherwise they fail to perform their function properly and epiphera will be the result. Projections

in various portions of the lid indicate the presence of tumors. If these are movable and free from the skin, a meibomian duct is occluded, resulting in the formation of a chalazion. If the lid is edematous, look for a point of local induration. This condition may accompany heart and kidney lesions, and some cases of trichinosis.

The **conjunctiva** should be transparent, showing the sclera beneath it. If it is congested, note carefully the location. An injection about the margin of the cornea indicates a cyclitis; a localized injection over the site of a muscular insertion is a symptom of localized tenonitis; an injection of the peripheral portion, with large radiating vessels, suggests glaucoma.

A severe chemosis suggests either a general tenonitis or some affection of the orbital tissues. It sometimes occurs with a purulent conjunctivitis.

The **cornea** under normal conditions should be transparent. If it is hazy, determine whether this is superficial or deep. If the epithelium is intact, and the reflex of a window-sash on the corneal surface is not bent or broken, the trouble lies posterior to Bowman's membrane. It may be due to interstitial disease or to a turbid aqueous and deposits on the posterior corneal layer.

The **pupils** should be of the same size, though rarely there is a slight difference normally. A large pupil in one eye indicates paralysis of the sphincter muscle, the use of a mydriatic, or glaucoma. A small pupil indi-

cates a reflex contraction from the presence of a foreign body or corneal ulcer, iritis, or the use of a myotic. Paralysis of the sympathetic causes a small pupil in both eyes. The pupils should be regular in shape. If irregular, iritis is usually the cause. If the pupil is not clear, look for a cataract, exudates in the chambers, or a turbidity of the vitreous.

The **iris** should be clear and lustrous. Both irides should be alike in this respect, though a difference in the amount of pigment exists in many cases. If the iris has lost its brilliancy and has changed its color somewhat, an iritis may exist. A tremulous iris is the result of loss of support, which is due to displacement of the lens, absorption, or previous extraction of the same. The iris is subject to cysts, tubercular growths, etc.

The normal **lens** is difficult to see because of its transparency; consequently, the pupil should be perfectly clear normally, so that light reflected through the pupil from the ophthalmoscopic mirror will show a red reflex, otherwise there is some opacity of the intervening media. Any opacity of the lens can readily be seen by oblique illumination or by the aid of a strong lens with the ophthalmoscope. A lens of 10 diopters will disclose floating bodies in the vitreous. A small opacity posterior to the lens center will move in the opposite direction to the movement of the eye. A complete cataract can be seen filling the whole pupillary space.

Always try the **tension** of the eye with the bulbs of the index-fingers. Place both fingers over the upper lid, above the cornea, and make gentle pressure. A sense of normal tension can only be acquired by practice. An increased tension indicates glaucoma, while a decreased tension is the result of a fluid vitreous.

## CHAPTER III

### DISEASES OF THE LIDS

From without inward the lids are composed of skin, a loose areolar tissue, muscle, the tarsus, and conjunctiva.

The skin is freely movable because of the loose tissue beneath it. It is continuous with the skin of the forehead, and blends with the conjunctiva at the margin. At this point is a growth of stiff hairs—the lashes—which arise from the margin of both lids usually, though the lower lid of the dog and pig present no distinct lower lashes.

The tarsus is the framework, and affords the lid firmness. The upper tarsus is larger than the lower. It is not cartilage, but it is composed of dense fibrous tissue. The tarsi are connected by the tarsal ligaments to the lateral walls of the orbit and to each other by the palpebral ligaments. It contains the meibomian glands, which are about forty in number. These glands are arranged in parallel rows, and they have their exit through small ducts which open at the margin of the lids, posterior to the roots of the lashes. The muscle-fibers are those of the orbicularis and, at the upper portion, the levator palpebrarum. The fibers of these

muscles run horizontally and vertically and are intimately associated.

The conjunctiva is the mucous membrane lining the lids. It is strongly adherent to the tarsus. Superior to the tarsus, it folds upon itself, forming a sort of culde-sac, known as the fornix conjunctivæ. This portion of the conjunctiva contains numerous glands, resembling the lacrimal gland in structure. The mucous glands afford a secretion to lubricate the lids in the act of winking and to moisten the cornea.

The lids contain a portion of the lacrimal apparatus. The outlet ducts from the lacrimal gland open at the posterior portion of the superior and external part of the upper lid. The drainage canals have their origin at points known as the puncta lacrimalia. These are situated near the inner angle of the lids, nearly opposite each other. Small canals run from these points, and these unite at the lacrimal sac, internal to the inner canthus. This sac leads into the nasal duct—a bony canal—which terminates in the nasal cavity opposite the middle turbinate.

The anatomic arrangement of these structures is somewhat different in quadrupeds and fowls. The puncta, instead of pin-point openings near the border of the lids, are large oval openings in the conjunctiva of the lids near the inner portion. The canals are also much larger in proportion.

The outer surface of the lids is subject to the same

diseases as other surfaces of the skin, and often, when skin diseases occur about the head and face, the eyelids become involved.

**Edema** is often a symptom of some remote disease, such as the heart or kidneys. It may also be caused by local infection, infiltration, and suppuration—the result of a blow, fracture of the bony orbit, or rupture of the orbital vessels, erysipelas, and other skin affections. Trichinosis is also a cause. It is doughy to the touch and may pit on pressure.

**Emphysema** is due to the escape of air into the cellular tissue from fracture of the wall of one of the adjacent sinuses, and may accompany emphysema of the neighboring structures. In this condition a crackling sensation is noticeable to the touch. It will subside as soon as the cause has been removed.

**Ecchymosis,** or "black eye," is due to rupture of the subcutaneous vessels and the effusion of blood beneath the skin. It is usually due to direct violence or to rupture of remote vessels. Ice-cold applications, evaporating lotions, or the lead-and-opium wash may be used with benefit.

**Burns** are caused by too hot applications, powder explosions, fires, caustics, etc. They are divided by degree, the same as burns on other portions of the body. The treatment depends upon the degree. Those of mild degree may be treated with dusting-powders of boric acid, etc., while the deeper burns should be treated

with soothing and antiseptic oils. Powder grains may be removed by the application of hydrogen peroxid 3 parts to glycerin 1 part. Ordinarily burns may be treated upon general principles. In severe cases ectropion may follow by reason of large cicatrices, and repair will have to be accomplished by plastic operations.

**Wounds** may be of the incised, lacerated, or contused type, and should be treated by general surgical measures. The surgery of the eyelid, however, is very difficult, when we consider the necessity of adapting well each of its important structures.

**Ectropion,** or eversion of the lid, is caused by burns, injuries, etc., which cause a cicatrix of the skin surface. When a severe ectropion exists the eye is very unsightly. The conjunctiva is constantly exposed and reddened. It becomes greatly irritated and inflamed by exposure and want of protection. Ectropion may also be the result of paralysis. The lower lid is more often involved, in which case the punctum is turned outward, and the tears, instead of flowing in their natural channel, flow over the cheek (epiphora) and cause much irritation. The treatment is principally surgical.

**Entropion,** or inversion of the lid, is caused by destructive diseases of the conjunctiva and tarsus. It is usually accompanied with trichiasis. Intense irritation of the cornea is the result of this condition, and often keratitis with opacities follow. The treatment is surgical.

**Lagophthalmus,** or inability to close the lid, is the result of paralysis of the orbicularis palpebrarum, through pressure upon or disease of the seventh nerve. Usually facial paralysis accompanies this condition when the affection of the nerve is posterior to the branches supplying the orbicularis. Destruction of the cornea may ensue by exposure. Temporary relief may be had by drawing the lids together, and keeping them closed by the use of adhesive plaster. The cause of the paralysis should be looked for and removed.

**Ptosis,** or drooping of the lid, may be partial or complete, and is due to paralysis of the levator palpebrarum by reason of pressure upon or disease of the third nerve, or that portion of it supplying this muscle. It may be congenital from absence of the muscle. Injury may also be the cause. In all cases of paralysis the treatment must be based upon general principles.

**Tarsitis,** or inflammation of the tarsus, is the result of old trachoma, syphilis, tuberculosis, etc. It is a chronic thickening of the tissue, with infiltration of the tarsal elements. It may follow chronic infection of the meibomian glands. The lid is thick and heavy over the site of the tarsus, and oftentimes partial ptosis and blepharitis are present. The treatment depends upon the cause. Resolvent ointments have been recommended combined with massage. In extreme and chronic cases the tarsus has been removed.

**Elephantiasis** is due to hypertrophy of the skin and

subcutaneous tissue. It may be confined to one lid only or both lids may be affected. It is often the result of continued attacks of inflammation of these tissues.

**Blepharospasm** is an involuntary contraction of the lid. It may be clonic or tonic in character. It is usually reflex, and is due to some irritation of the seventh nerve. The lid is spasmodically contracted when a foreign body is present and also in some diseases of the cornea. The mild clonic type is often due to nervous diseases, chorea, habit, etc. In these cases nerve tonics and rest are of benefit. In the animal, more likely a foreign body is the cause. Remove the cause.

**Ankyloblepharon** is a condition in which the edges of the lids have grown together. It is usually caused from traumatism or disease, or may be due to a congenital defect, when the lids fail to open, as is often seen in kittens and other pets. An operation is the only relief, though in congenital cases the lids will usually separate if one will give nature sufficient time to do its work.

**Blepharitis marginalis,** an inflammation of the lid, is known as blepharitis, but the former term designates a local inflammation along the margin. There are two principal types—the superficial and the ulcerative. The superficial type is manifest by the presence of redness and swelling, together with the formation of crusts, which usually occur about the lashes, and frequently cause them to fall out by slight friction. The hair-

follicles are not involved, and the lashes grow again by proper treatment. It often occurs in strumous subjects, and accompanies catarrhal and other types of conjunctivitis and the presence of pediculi.

In the ulcerative type the above symptoms are present, but more severe, together with ulceration, which occurs beneath the crusts. This ulceration invades the hair-follicles, and when the lashes are once lost they fail to grow again. It is often due to infection. Severe itching is often present, and rubbing the lids tends to create a fresh focus for the growth of the organisms. The lids are heavy and partly closed, and the matting together of the lashes with crusts and secretion makes the animal look as though it were suffering with some severe constitutional disease.

*Treatment.*—This should be directed to the cause. If conjunctivitis or other diseases of adjacent structures exist, they should be met by appropriate therapeutic measures.

In mild cases soften the crusts with vaselin, and, after this has remained on for several hours, wash it off with a mild alkaline solution, remove the crusts that may remain, and apply an ointment composed of yellow oxid of mercury 6 grains, and vaselin 1 ounce.

In the ulcerative type the above treatment may be employed, and when the lids are free from crusts the ulcers may be touched with a 2 to 10 per cent. silver nitrate solution, the tincture of iodin, or a 25 per cent.

solution of carbolic acid in alcohol. This treatment should be repeated as occasion requires, and care should be exercised that none of the solutions get into the eye. The general health of the animal should always be considered.

**Hordeolum,** or **stye,** is a localized infection about a hair-follicle, resulting in suppuration. A stye may occur independent of blepharitis, though they often occur together. Pain, localized tenderness, and swelling are the prominent symptoms. In some cases a profound edema of the whole lid occurs. Styes often appear in succession, or two or more may occur at the same time. In the late stage of suppuration they tend to point and rupture of their own accord.

*Treatment.*—Much the same treatment as in blepharitis may be employed. When the stye points it is better to open it with a small sharp-pointed instrument and express the contents. Protect the opening with a little flexible collodion.

**Chalazion.**—This is a disease of the meibomian glands, situated in the tarsus, and the result of stoppage of the outlet ducts which open at the inner edge of the lid, just posterior to the roots of the lashes. It is manifest by a localized tumor in the lid, movable and free from the skin. As the meibomian gland is essentially a sebaceous gland, a chalazion is like a sebaceous cyst in character and is filled with sebaceous matter. It often goes on to suppuration, and may discharge its contents either

through the skin or conjunctival surface. It may, however, become absorbed before reaching the stage of suppuration and disappear spontaneously, or it may remain permanently enlarged and undergo fibroid change. Large tumors press upon the eyeball and produce much discomfort, besides, they are very unsightly.

*Treatment.*—In the early stages the tumor can sometimes be aborted by gradually milking, or pressing out the contents of the duct, and allowing free drainage. If suppuration has taken place, the lid may be everted and the tumor incised at the place of pointing, and the contents scraped out with a small curet. If the tumor remains chronically enlarged, as it often does, it is better to dissect it out from the skin surface. By this method the sac and all may be removed, and there is less liability of the tumor recurring. They may appear in other portions of the lid or several tumors may coexist. When excised from the outside the parts may be brought together with a single stitch and the whole covered with collodion.

**Tumors of the Eyelid.**—The lid is subject to benign and malignant growths. The former are the angioma, a vascular tumor, and usually congenital; the granuloma, an excess growth of healthy tissue, is nature's attempt to heal a wound, which may appear as a flat growth, covering a large surface, or a polypoid soft growth at the mouth of a sinus, a papilloma or wart on the surface or border

of the lid, and certain growths of a horny nature about these localities.

The malignant tumors are the sarcoma and the carcinoma. The former occurs in the young, though often seen in older subjects, either as a primary tumor or extending from sarcoma of the orbit.

Carcinoma occurs as an epithelial cancer, characterized by a slow ulceration, like epithelioma in other portions. A diagnosis can properly be made only by the use of the microscope. The proper treatment in the case of all tumors is excision of the same. The malignant types, especially the epithelioma, have been treated by the *x*-ray with excellent results.

**Ulcers of the Lid.**—Ulcers of the skin surface of the lid are not infrequent as the result of burns and other injuries and local and constitutional diseases. Lupus is particularly liable to affect the lid when the skin in the immediate region is diseased. Cowpox and other skin affections which may attack the lid may be followed by ulceration.

The cause must be treated as well as the ulcers themselves. Cleanliness is one of the main things to observe, together with protection and stimulation to healthy granulation, as in the treatment of ulcers of other portions of the body.

**Abscess of the Lid.**—This is often phlegmonous in character, and is caused by direct injury, diseases of the bones in the neighboring region, erysipelas, or anthrax.

The general symptoms of purulent inflammation accompany it—edema, induration, swelling, pain, and tenderness on pressure. The swelling is so intense as to completely close the lid. The pus is diffused through the tissues, and gangrenous destruction of the tissues may result. This is followed, in the process of healing, by cicatrices, which interfere with the closure of the lid or produce ectropion. Both lids are often affected.

*Treatment.*—As soon as one can determine the presence of pus, a free opening should be made and drainage established, hot bichlorid compresses applied, and every effort made to get the best results and prevent as little deformity as possible in the process of healing. Coexisting conditions should always be sought for and promptly treated.

**Trichiasis.**—This is an abnormal position of the eyelashes. They grow inward or backward toward the globe, instead of outward. It is often caused by contraction of the inner surface of the eyelid from diseases of the conjunctiva and tarsus. It produces great irritation of the cornea by constantly scratching it in the act of winking. If this irritation continues, inflammation and opacity of the cornea may follow.

*Treatment.*—If only a few lashes turn inward they may be extracted with a pair of forceps. This operation must be repeated at regular intervals, for the short stubby lashes that grow again cause more irritation than the long silky ones. The hair-follicles may be

destroyed by electrolysis. If the condition is general and accompanied with entropion, as it often is, one of several operations may be performed.

**Distichiasis.**—This is a double row of lashes on the same lid. The posterior row may be removed by special operation.

## CHAPTER IV

### OPERATIONS ON THE LIDS

Operations on the lids are necessary to correct certain deformities, such as ectropion, entropion, trichiasis, and ptosis. In doing operations on the lids requiring incisions of the external parts in animals the hair should be shaved from the part incised, so that it will not be caught in the wound when the sutures are applied.

The same antiseptic and aseptic precautions should be used as in doing operations on other portions of the

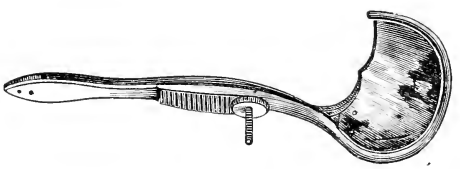

Fig. 9.—Knapp's lid clamp. (de Schweinitz, "Diseases of the Eye.")

body, but the operator should be careful that strong antiseptic solutions do not enter the inner portion of the lids and injure the cornea. The lid clamp or horn spatula (Fig. 9) should be placed beneath the lid to afford more resistance and firmness when making incisions and to protect the eyeball. This should be sup-

ported and gently raised by an assistant during the operation.

The illustrations of these operations are shown on the human eye, and are taken from Dr. de Schweinitz's work on "Diseases of the Eye," published by W. B. Saunders Co.

**Ectropion.**—There are numerous operations for the correction of ectropion. One of the simplest is the Wharton Jones' operation (Figs. 10 and 11).

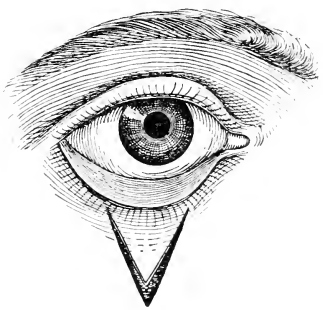

Fig. 10.

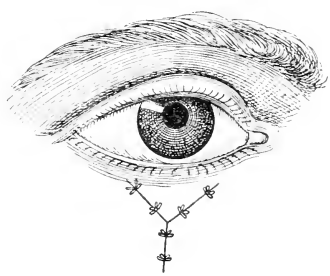

Fig. 11.

Figs. 10, 11.—Wharton Jones' operation for ectropion. (de Schweinitz, "Diseases of the Eye.")

A V-shaped incision of the skin is made, the apex extending downward. The skin is undermined, and the central portion elevated, when the whole is brought together as shown in Fig. 11. This allows a more lax condition of the skin of the lid, and is a good operation in ectropion following small cicatrices.

Success has been attained in numerous cases by the writer by doing the Kuhnt-Szymanowski operation, which

is described as follows by Meller in his work on "Ophthalmic Surgery." He divides the operation into four steps: The first step consists in "splitting the lower lid in the intermarginal border." He uses a lancet or keratome for this purpose, passing it in between the skin and the tarsus, using the thumb and index-finger as a guide, so that the tarsus or skin will not be wounded. He starts "slightly to the inner side of the middle of the lid and goes exactly to the external canthus."

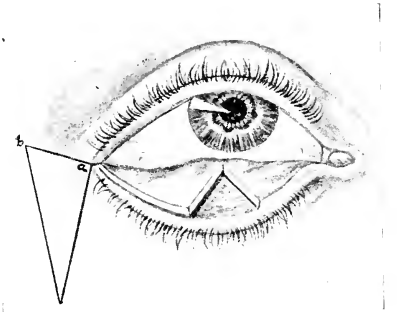

Fig. 12.—Showing the formation of the triangle of skin, which is later removed. (de Schweinitz, "Diseases of the Eye.")

As the lid is very vascular, hemorrhage must be stopped with adrenalin or compression.

"The second step is the excision of a triangular piece from the tarsus." The size of this piece depends upon the degree of the deformity. This piece is best excised with a strong pair of straight scissors. The overlying conjunctiva is, of course, included in the excision.

"The third step consists in the excision of a triangular

piece of skin from the region of the external canthus." This excision is first mapped out, and the skin divided with a sharp scalpel.

"The fourth step consists in uniting the open wounds." First unite the wound in the tarsus, then apply the sutures in the skin of the lid, as shown in Fig. 13.

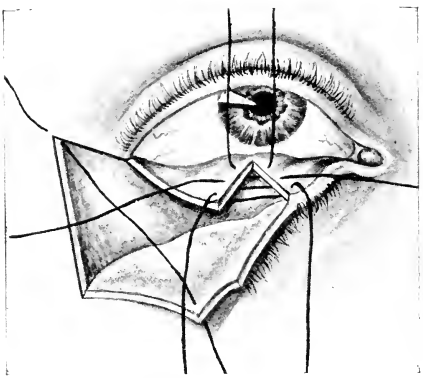

Fig. 13.—Showing the condition after the excision of the triangular piece of skin and the undermining of the lid, which is turned outward. The sutures are in place. (de Schweinitz, " Diseases of the Eye.")

The object is to unite the parts neatly, and to produce traction on the lower lid to hold the tarsus, which was everted, in its normal position.

The sutures may be removed in from five to seven days, but it is well to let them remain long enough for good union to take place. If the operation is done under aseptic precautions, the wounds will heal by first intention.

At a meeting of the American Medical Association,

in 1909, Dr. S. Lewis Ziegler described a method of "galvanocautery puncture in ectropion and entropion." He uses a special clamp for this purpose, in which the lid is fixed; then makes, in ectropion, about six punctures of the tarsus at equal distances apart with a special galvanocautery tip. For entropion, the punctures are made on the skin surface. He has seldom seen any reaction following its use. If after the first operation the result is not satisfactory, the operation may be repeated in two or three weeks.

In extensive cicatrices, or in cases of destruction of the tissues of the lid, plastic operations are often done to restore the lid. Such operations are well illustrated in Figs. 14–17.

The cicatrix or ulcerated surface is excised and new tissue supplied by a flap from the cheek or forehead. If too much tension is produced in drawing together by sutures the wound from which the flap was taken, it may be covered with Thiersch grafts. Such grafts are taken from the leg usually. The hair must first be shaved and the site made as aseptic as possible. A portion of the upper surface of the skin is then cut away with a to-and-fro motion of the razor. The razor should be flooded with normal salt solution, so that the grafts will slide off easily without curling. They should be immediately transferred as soon as all bleeding has been stopped. The grafts are then protected with per-

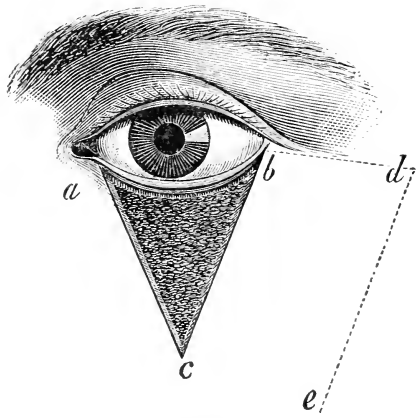


Fig. 14.

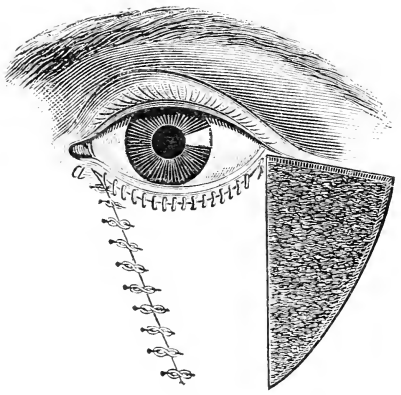


Fig. 15.

Figs. 14, 15.—Restoration of the lower lid by Dieffenbach's method. The diseased tissue has been removed in a triangular flap, *a–b–c*. This defect is covered by a flap taken from the cheek, indicated by the dotted lines, *b–d*, *d–e*, with the result shown in Fig. 15. The remaining gap may be covered with Thiersch grafts. (de Schweinitz, "Diseases of the Eye.")

forated rubber tissue, over which is placed a compress of sterile gauze wet with normal salt solution.

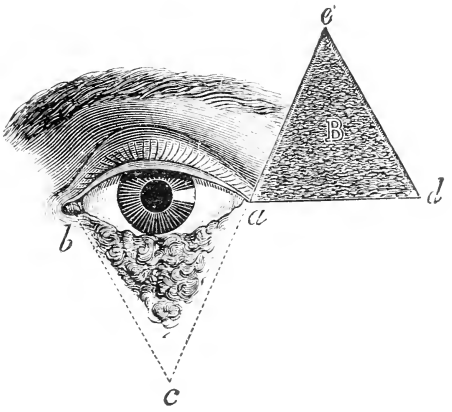


Fig. 16.

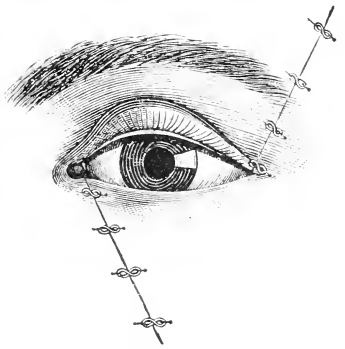

Fig. 17.

Figs. 16, 17.—Restoration of lower lid by Burow's method. The diseased tissue is removed with the flap *a–b–c*. The horizontal incision is prolonged upon the temple and forms the basis of the triangle *a–d–e*. This flap (*B*) being removed, the cutaneous flap *a–c–d* is dissected up and drawn inward so that the angle *a* is sutured at the point *b*, and *a–d* forms the free border of the lid. *c–a* is now united with *c–b*, and *d–e* with *a–e*, with the result shown in Fig. 17. (de Schweinitz, "Diseases of the Eye.")

**Entropion.**—This is mostly confined to the upper lid. To correct this it is necessary to cause traction

of the skin upward. The Hotz-Anagnostakis operation meets the indications (Fig. 18).

"A transitive incision from canthus to canthus is made through the skin and subjacent tissue." The incision should be slightly curved, and should follow the upper border of the tarsus, 6 to 8 mm. above the border

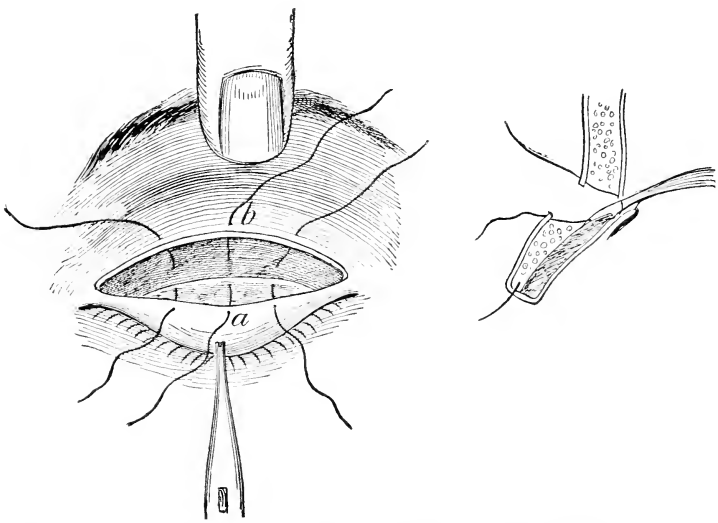


Fig. 18.—Operation of Anagnostakis and Hotz. (de Schweinitz, "Diseases of the Eye.")

at the center and 2 mm. above the canthi. The wound is then separated, and a narrow bundle of the muscle-fibers, which run transversely with the upper border of the tarsus, is exsected with the scissors and forceps. Three sutures are applied, one in the middle and one at each side, at about equal distances apart. The center needle is first introduced through the skin only

of the lower portion of the wound, then thrust through the upper border of the tarsus and the tarso-orbital fascia, as well as the skin at the upper portion. The lateral needles are placed in the same manner. A good needle-holder should be used in this operation, as well as in all operations on the lids (Fig. 18).

**Trichiasis.**—The above operation is a very satisfactory one for the correction of this condition.

When only a few lashes turn inward they may be extracted with a pair of cilium forceps (Fig. 19). The lashes may grow again, and the short stubby hairs

Fig. 19.—Cilium forceps. (de Schweinitz, "Diseases of the Eye.")

cause much irritation of the cornea if they happen to be central.

Electrolysis is used with success in some cases to destroy the hair-follicles. One can make an apparatus with three dry cells, two pieces of wire, a needle, and a sponge. Connect the batteries, and connect the wire with the needle on one end, to the negative pole; to the positive pole attach the wire with the sponge on it, and the apparatus is ready for use. Pass the needle, parallel with the hair, to its root. Wet the sponge and place it on the cheek or forehead, after denuding the spot of hair. As soon as the contact is made a whitish foam will appear about the entrance of the needle. The sponge

can now be removed and the needle withdrawn, when the lash will be easily extracted, root and all.

When trichiasis is complete, ablation of the hair-follicles according to Flarer's method is the best to perform. The lid is split posterior to the roots of the lashes, and just anterior to the openings of the meibomian ducts, the full length of the lid, transversely, then again split anterior to the lashes, the scalpel meeting the bottom of the first incision, just beyond the roots. The portion containing the cilia, complete, must then be detached, and the wound allowed to heal by granulation.

When the palpebral fissure is contracted by reason of chronic diseases of the conjunctiva, which often causes entropion and trichiasis, an operation known as canthotomy may be performed. A pair of straight, blunt-pointed scissors is placed horizontally, one point beneath the outer canthus and the other above, when the tissues between the blades are divided with one snip. This relieves the pressure of the lid on the cornea and relaxes the tension of the border of the lid.

*Canthoplasty* is the term used for this operation when sutures are applied. These sutures are usually used, one at the extreme angle of the wound and one above and one below, bringing the conjunctiva and skin together (Fig. 20).

*Tarsorrhaphy* is performed when it is desired to decrease the length of the palpebral fissure. A small

flap, including the hair-follicles, is removed from the upper and lower lids, at the outer angle, the length of the flaps to be determined by the amount of correction desired, and the denuded surfaces are then united by sutures.

**Ankyloblepharon.**—A complete division of the lid may be made at the natural line of separation. Begin at the outer canthus, pick up the lid with the fixation

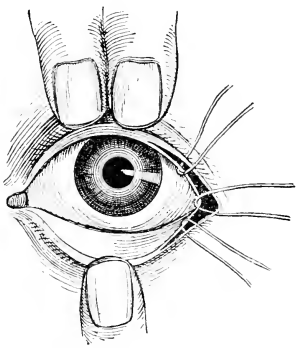

Fig. 20.—Canthoplasty. (Meyer.)

forceps, and make a small horizontal slit through the lid, being careful not to wound the globe. Pass a small grooved director through this opening, and with it gently raise the lid from the eye. Pass in a pair of small sharp, probe-pointed scissors to the heel, and, directed by the probe, divide the lid with one cut, if possible, to the inner canthus. Fine silk sutures should be used to unite the conjunctiva to the skin, using care that the knots remain externally.

Union readily takes place, and the sutures may be removed in about four days.

One should not be too ready to do this operation, as nature may perform her work, if given sufficient time, in the case of all pet animals.

**Ptosis.**—Panas' operation for ptosis is probably one of the most popular. Posey gives an excellent description of the operation as follows: "Two horizontal incisions are made, the lower at the orbital margin, and along the top of the flap with a slight convexity upward, and not quite an inch long; the higher one a little longer, and at the upper border of the eyebrow. A flap of the skin and muscle is now dissected from the tarsus down to the ciliary border, but the septum orbitæ (suspensory ligament) of the lid is not disturbed. The bridge of tissue between the two horizontal incisions is undermined without cutting the periosteum or septum orbitæ. The flap is then drawn up under the bridge by means of sutures and fastened to the upper edge of the higher incision. When the flap is so fixed, the traction tends to cause ectropion, and a suture is, therefore, placed at each side, passing deeply through the septum orbitæ and conjunctiva, but not the skin, and it also is inserted in the upper lip of the higher incision, so as to correct the tendency to eversion."

## CHAPTER V

### DISEASES OF THE LACRIMAL APPARATUS

THE principal diseases of the lacrimal apparatus in the animal are those which affect the lacrimal sac and nasal duct.

**Dacryocystitis.**—This is an inflammation of the lacrimal sac. It may be catarrhal or purulent. In the purely catarrhal type the sac becomes somewhat thickened and distended. There is considerable tenderness on pressure and the sac is fuller than normal. By deep pressure a mucosecretion can be pressed out through the puncta, though if the duct is free, that is, if there is no stenosis, it may be pressed downward through the duct. In the purulent type the sac becomes very greatly distended, and is exceedingly tender upon pressure. The outlet of the duct is usually occluded and the tears flow over the cheek (epiphora). If not early treated the case takes on the appearance of an abscess, and the wall of the sac ruptures and the pus finds an exit through the skin at a dependent portion. Oftentimes a permanent fistula is the result of this condition.

If the case is at the point of rupture an incision should be made, and, under a local anesthetic, the sac may be cureted and a solution of nitrate of silver applied. It is well to establish the drainage canal if possible, and pass through it a solution of argyrol, then some boric acid solution. Keep the sac clean and free from pus. Should it become permanently or chronically affected, the best thing to do is carefully to dissect out the sac. This should be done during the stage of quiescence.

**Stenosis of the Nasal Duct.**—This almost always accompanies the above disease, and is due to thickening and adhesion of the mucous lining of the duct. In man, the duct is probed from above, through the puncta —usually the lower one. The point of the probe is passed into the punctum in a vertical position, then, placed horizontally, it is pushed through the canaliculus to the bony wall, then, again in a vertical position, it is gently pushed until it engages in the upper portion of the duct, when it is forced firmly, but gently, downward through the duct. In the animal, the probes used are much larger and longer than those used in man, and, instead of being inserted from above, they are inserted in the outlet of the duct below, opposite the middle turbinate bone in the nose. After the point of the probe is engaged it is pushed upward to the sac, gently breaking up the adhesions in its course. This operation should be repeated two or three times a week, according to the indications.

# CHAPTER VI

## MUSCLES OF THE EYEBALL

The muscles that move the eyeball are known as the extrinsic muscles. In the animal they are seven in number—the superior rectus, the inferior rectus, the external rectus, the internal rectus, the superior oblique, the inferior oblique, and the retractor. This last muscle is not present in man.

All of these muscles, except the inferior oblique, have their origin at the apex of the orbit, near the margin of the optic foramen. The recti muscles pass forward in their respective positions, and are inserted into the outer surface of the sclerotic coat. The superior oblique passes through a pulley, near the internal angular process of the frontal bone, at which place the muscle assumes a rounded, tendinous formation; from there it passes in an external direction, expands, and is inserted into the sclerotic between the superior and external recti. The inferior oblique arises from the orbital plate of the superior maxillary, passes externally, and is inserted into the sclerotic near the superior oblique, posterior to the equator. Both of these muscles pass beneath the recti in their course horizontally.

The distance of the insertion of the muscles from the

corneal margin depends upon the animal and the size of the eye. In man the recti muscles are inserted from

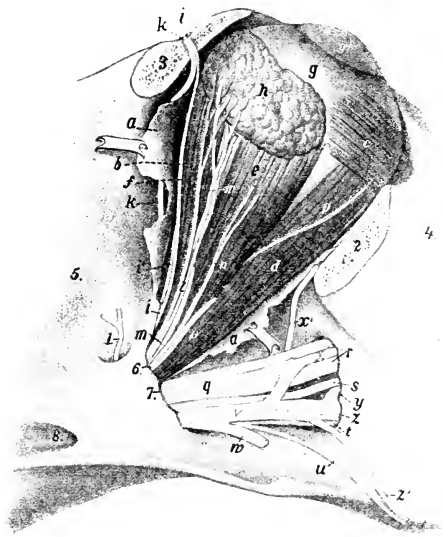


Fig. 21.—Right eye of horse: *a*, Remnants of periorbita; *b*, levator palpebræ superioris; *c*, obliquus oculi inferior; *d*, rectus oculi inferior; *e*, rectus oculi externus; *f*, rectus oculi superior; *g*, sclera; *g'*, cornea; *h*, lacrimal gland; *i*, frontal nerve; *k*, frontal artery; *l*, branch of lacrimal nerve to gland; *m*, lacrimal artery; *n*, zygomatic nerve; *o*, branch of ophthalmic artery; *p*, branch of oculomotor nerve to obliquus oculi inferior; *q*, maxillary nerve; *r*, infra-orbital nerve; *s*, posterior nasal nerve; *t*, great palatine nerve; *u*, small palatine nerve; *v*, internal maxillary artery; *w*, buccinator artery (cut); *x*, infra-orbital artery; *x'*, malar artery; *y*, sphenopalatine artery; *z*, great palatine artery; *z'*, small palatine (or staphyline) artery; *1*, posterior deep temporal artery; *2*, *3*, stumps of orbital margin; *4*, facial crest; *5*, temporal fossa; *6*, foramen lacerum orbitale; *7*, anterior end of alar canal; *8*, posterior opening of same. (After Ellenberger, in Leisering's Atlas.)

7 to $7\frac{1}{2}$ mm. from the cornea, while the oblique muscles are inserted much farther back—about 17 to 18 mm.

The action of the muscles are as follows: The external and internal recti cause the eyeball to move outward and inward respectively, and they balance, so to speak, the horizontal movements. The superior rectus causes an upward and slightly inward movement, while the inferior rectus causes a downward and inward movement. The oblique muscles cause the eyeball to rotate on its anteroposterior axis. They oppose or balance the movements of the superior and inferior recti.

The retractor is the largest and most powerful muscle of the eyeball. It has its origin in common with the recti muscles, surrounding the optic foramen, passes forward, completely encasing the optic sheath, expanding in a funnel shape, and is inserted into the posterior third of the sclerotic coat. Its function is to pull the eyeball backward.

The insertion of the muscles are tendinous, and these tendons are ensheathed in a fascia, which is in reality a portion of Tenon's capsule.

All the extrinsic muscles, except the superior oblique and the external rectus, are supplied by the third cranial nerve. The superior oblique is supplied by the fourth cranial nerve, and the external rectus by the sixth cranial nerve.

## Affections of the Muscles

In man we have many affections of the muscles, because the eyes are so placed to produce, in a normal case,

perfect binocular vision; hence, refractive errors, causing a greater effort to see, particularly close objects, tend to produce a weakness of one or more of the extrinsic muscles, resulting in a turning outward or inward of a few degrees of one or both eyes. The condition is hardly noticeable, though it is brought out by certain forms of examination.

This may go on and on until the position is easily seen by a second person, and the eye assumes the appearance of being crossed. He may be able to see with either eye singly and normally, but the eye that is covered, or not fixing, turns outward or inward, as the case may be. He may be wholly dependent upon one eye, and the eye that is not used becomes partially blind (amblyopic).

This is not so in the animal, because of the position of the eyes and numerous other reasons. A cross-eyed animal is seldom ever seen. They may, however, be subject to paralysis of the muscles, by reason of pressure upon or disease of the nerves supplying those muscles, the same as in man.

One needs only remember the anatomic relations, action, and nerve supply to determine which muscle and nerve is involved.

**Ophthalmoplegia.**—This is a condition in which all the muscles are paralyzed. There being no resistance, the eyeball stands out prominently from the orbit and is immobile. The lid may droop (ptosis) because of

paralysis of the levator palpebræ. There is little that can be done except to protect the cornea; look for the cause and remove it if possible. Usually the trouble is in the brain at the nerves' nuclei. When extensive, other symptoms of cerebral affection accompany it.

## CHAPTER VII

### DISEASES OF THE CONJUNCTIVA

CONJUNCTIVITIS is an inflammation of the conjunctiva. It may occur as a simple congestion of the membrane or be accompanied by edema of the tissue, with or without secretion, varying in character. It may be acute, subacute, or chronic in its nature, and occur with inflammation of other portions of the eye.

**Acute Catarrhal Conjunctivitis.**—In mild cases the conjunctiva of the lids only is affected, while in more profound cases the whole conjunctiva is involved, and presents a bright red appearance, with enlarged vessels radiating on the globe. The swelling of the tissue is often intense toward the tarsal fold and the inner angle. In some cases small hemorrhagic spots occur which may be isolated. These may remain so, though they not infrequently coalesce, forming large patches. There is an increased lacrimal secretion at first, which later changes to a mucopurulent character. In consequence of this the inner canthus is constantly moist. The secretion may flow over the lids and create an irritation of the skin and the formation of crusts. In the morning the lids are usually stuck together and the lashes are matted

with the secretion. If allowed to continue, it causes an inflammation of the margin of the lids and a loss of the lashes.

As a rule, there is not much pain—unless a foreign body is present—but there is a tendency to keep the eyes closed because of the sensitiveness to light. Itching is an almost constant symptom at first, and the animal, in attempting to stop it, rubs its head against some object, which irritates the eye and makes matters worse.

The subacute type follows the acute, and, if not properly treated, lapses into the chronic stage.

The *causes* are numerous, though the principal one is infection or the introduction of bacteria. Animals may get into their eye such substances as chaff, seeds, dust, insects, hair, etc., or the eye may be struck with a whip or twig. Bacteria may extend to the eye from the presence of catarrh and other affections of the nasal tract. Strong gases, smoke, glaring light, hot air, cold drafts, filthy and damp stabling, and a loss of health generally may cause it. It often accompanies influenza, pneumonia, glanders, and other diseases affecting the mucous tracts, and in such cases the same organism causing these diseases causes the conjunctivitis.

*Diagnosis.*—The extreme redness of the conjunctiva, together with secretion, the presence of pupillary reaction, normal tension, and a clear cornea will serve to exclude other conditions.

*Treatment.*—The main indication in all cases is to find the cause and get rid of that. First examine the eye carefully for the presence of a foreign body. This may be found in many cases only by the closest inspection with condensed light and a magnifying lens.

If the secretion is purulent in character a smear should be made, and this examined with the microscope to determine what particular organism the inflammation is due to. If the eye is sensitive to light, the cornea should be examined for excoriations of the epithelium.

The general condition should always be cared for and the eye kept as clean as possible. In mild cases a solution of

| | |
|---|---|
| Sulphate of zinc | gr. j; |
| Boric acid | gr. xx; |
| Distilled water | ℥j. |

Mix.

is sufficient if dropped into the eye several times a day. If the case is a severe one the conjunctival surface may be brushed lightly with a 2 per cent. solution of silver nitrate, and immediately washed off with a normal salt solution or clear water. If no corneal complications exist, cold applications are indicated. Strong light should be excluded and the animal allowed to exercise after sundown.

**Chronic conjunctivitis** may follow the acute type, and often exists a long time. The conjunctiva is somewhat thickened, and the secretion is scanty and of a mucoid

character, and is deposited, in conjunction with the secretion of the meibomian glands, at the angle of the lids. In some cases there is no secretion and the membrane is reddened and dry. When this is the case increased winking occurs in order to moisten the cornea. Winking may be increased also when there is a thickened secretion, to free the cornea of the mucoid filaments which stick over the pupillary area and interfere with vision. These filaments may also form in folds and act as a foreign body in the eye. The lids become heavy and drowsy in appearance. The secretion upon the margin of the lids may produce a blepharitis. At this stage loose lashes drop out, and find their way into the eye by rubbing it against some object to relieve the itching and burning sensation. The lower lid is often depressed or everted and the tears flow over the cheek, because the lower punctum is drawn away from the globe.

This type is often seen in animals that are in poor health. Pasturing in low and damp lands is said to cause it even in young foals. Dust, wind, smoke, and irritating gases are common causes. It is often associated with skin diseases about the head and face. Duane says, "Usually the chronic form of conjunctivitis (in man) is that produced by the diplococcus of Morax-Axenfeld. There may be very little injection of the conjunctiva, no swelling of the latter, and little or no secretion." On the other hand, the writer has seen

several cases of conjunctivitis caused by this organism which were of a severe purulent type. This shows that even in the eye there is a difference in the degree of virulence of bacteria of the same kind.

The *treatment* is practically the same as in acute conjunctivitis. If little or no secretion exists, a solution of alum or zinc sulphate in about $\frac{1}{5}$ of 1 per cent. acts favorably, or the conjunctiva may be gently rubbed with the alum stick every day or two. Zinc sulphate is a specific in conjunctivitis caused by the Morax-Axenfeld bacillus. Glycerin tannate brushed over the conjunctiva is desirable in some cases. If crusts form about the margin of the lids, apply the yellow oxid of mercury ointment every night, and wash it off the next morning with a solution of bicarbonate of soda. This will soften the crusts, when they can be more easily removed. It also prevents the lids from sticking together, and allows the secretion to flow out, if there is any. The general health must be taken into consideration, and any unhygienic condition of the stable or pasture must be corrected.

**Purulent conjunctivitis** is also known as purulent ophthalmia, and in many cases resembles an acute catarrhal conjunctivitis, accompanied with more edema of the conjunctiva and an excess of purulent secretion.

It is caused by a variety of pyogenic organisms, but the more common cause in man is an infection with gonorrheal pus, when it is spoken of as gonorrheal

ophthalmia. Law says, "Moller records a widespread epidemic of gonorrheal ophthalmia in dogs in Berlin and environs in 1883." As a rule, animals seem to be exempt from infection of the gonorrheal pus of man, though Frohner succeeded in infecting the eye of a dog from such a source. Horses, dogs, cattle, sheep, and swine are susceptible to purulent ophthalmia.

Crowded and filthy conditions are, as a rule, the cause, and if pyogenic organisms find their way into the eye the chances are a purulent conjunctivitis will follow, as there is no better medium for the development of such bacteria.

Cases may be sporadic, though epidemics occur among animals in closely crowded quarters. One animal may be the cause of the infection of a whole herd, as hundreds of cattle have been attacked in a few days through the introduction of one case among them.

In cases of the so-called "enzoötic ophthalmia" animals are said to be exempt from succeeding attacks, probably from an established immunity.

The *symptoms*, at first, resemble an acute catarrhal conjunctivitis, but soon the true nature of the case is manifest by the presence of pus, which is thin and mucoid at first, but later it becomes thick and greenish-yellow in color. The swelling of the conjunctiva and lids is often so intense that it is difficult to separate the lids sufficiently to examine the eye properly.

If the disease is not controlled the corneal epithelium

becomes softened by maceration and erosion, and ulceration of the cornea follows. The bacteria may burrow into the deep structure of the eye, causing inflammation of these parts and probably the loss of the eye.

*Treatment.*—Cleanliness and antiseptic applications are the principal indications. First wash the eye with a saturated solution of boric acid, then drop in a 25 per cent. solution of argyrol. In a few minutes wash this out and carefully remove the shreds of pus which the solution has coagulated. Then apply another drop, and allow it to remain. Repeat this operation every three or four hours or oftener if necessary. After the secretion has been controlled, use a weaker solution less often applied. A 2 per cent. solution of silver nitrate brushed over the everted lids, and immediately washed off, is of benefit in many cases. If this is used, one application a day is sufficient. If there is much swelling of the lids an ice-cold application, frequently repeated, is of value. It should not be allowed to remain long enough to become warm, for, in that case, it acts as a poultice, and encourages the growth of the bacteria. If the cornea is involved, hot applications should be used. Encourage the animal to keep the eye open as much as possible to prevent corneal complications. This can be accomplished to a great degree by isolating it in a clean, darkened stall, and frequently cleansing the eye of the secretion, which causes a reflex closure of the lids.

When one eye only is affected, the other eye should

be protected with a pad after it has been thoroughly cleansed with an antiseptic solution.

Conjunctivitis during attacks of *cow-* and *sheep-pox* is due to the same pathologic conditions that exist in the skin. This type is most virulent. The lids are extremely swollen and the secretion is usually profuse. The characteristic lesions on the conjunctiva tend to coalesce, forming a large area of ulceration. If it is not early controlled it may terminate in ulceration of the cornea, perforation, and loss of the eye.

The treatment is the same as for purulent conjunctivitis, together with that for ulceration of the cornea.

**Phlyctenular Conjunctivitis.**—This is vesicular eruption of the conjunctiva, and often accompanies eczema and other skin affections. The vesicles vary in size from a pin-point to a pin-head or larger. They may be single or multiple. A favorite site is near the corneal margin. They often invade the cornea, when it is known as a phylctenular keratitis. The vesicles contain a semifluid of yellowish appearance, said to be due to the presence of staphylococci, but late investigators show that tubercular infection may be the cause. The apex of the vesicles break down, when they may terminate in resolution or ulceration.

One afflicted with phlyctenular disease of the cornea or conjunctiva shows typic symptoms in many cases. There is much photophobia, and strong contraction of the muscle closing the eye, and the head is carried in

a bowed position. The phlyctenules have a grayish or yellowish appearance, and are often supplied with numerous blood-vessels branching toward them. As the disease occurs principally in scrofulous subjects, we often have malnutrition, enlarged lymphatics, eczematous crusts about the nose and ears, and blepharitis marginalis with crust formation. In very mild cases most of these are absent, and only a mild irritation of the eye is noticeable.

As many of the mild cases seem to be caused by errors of diet, a regulation of this alone will often effect a cure. In all cases of malnutrition suitable tonics should be given to tone up the system. Skin affections should be appropriately treated. Mild antiseptic colleria may be used, and when ulceration has taken place the yellow oxid of mercury ointment is of great benefit applied three times a day.

**Trachoma.**—This disease is principally confined to man, though monkeys are subject to it. It was known in the far eastern countries centuries before the time of Christ. It is the disease which at the present time checks foreign immigration, and close inspection is made of the eyes of all immigrants before landing on our shores. Some, no doubt, escape detection, for it prevails principally among the foreign population, notably Hungarians, Italians, and the lower class of Jews. It is often seen in persons of a higher class. It is one of the diseases that causes a large percentage of blindness.

It is no doubt due to some form of bacterium which has not yet been definitely settled upon. The writer has recently examined several cases by culture growth under the strictest precautions, and found a bacilli resembling the Klebs-Löffler in nearly all their peculiarities. The disease is said to be contagious by some, but this is doubted by others. It attacks the scrofulous, debilitated, and otherwise poorly nourished, though the writer has seen it in those who are well nourished, lead outdoor lives, and have sanitary homes.

It is confined principally to the palpebral conjunctiva, and usually involves both eyes. The initial symptoms are much like those of a catarrhal conjunctivitis, and in many cases the disease is well advanced before the patient is aware of its real nature. A secretion is developed of a mucopurulent character and follicles are numerous. These resemble sago grains, and are confined to the lymphoid structure. They eventually break down, discharge, and cicatrize while others are forming. A gritty feeling is experienced in the act of winking, and, by reason of this and an extension of the disease, the upper part of the cornea becomes irritated and inflamed. This is known as pannus. The thickened tissue produces a slight drooping of the lid. When the conjunctiva is exhausted by extensive ulceration and cicatrization a degree of contraction takes place, and the border of the lid is drawn inward, producing an entropion. This is

more so when the tarsus is involved. The disease usually becomes chronic.

*Treatment.*—To obtain the best results treatment should be commenced early in the disease. If the follicles are full and numerous the radical treatment is the best. This consists of an expression, or squeezing out, of the follicle contents with a Knapp's or Prince's forceps. The conjunctiva is then scrubbed with a solution of corrosive sublimate of 1 : 1000 or even 1 : 500 parts, and then washed with distilled water. Iced antiseptic applications for twenty-four hours will allay the reaction. When the conjunctiva has recovered, and there is a tendency to recur, it may be rubbed lightly every second day with a crayon of sulphate of copper. If the secretion persists, argyrol in 25 per cent. solution may be used, applied every three or four hours, or silver nitrate in 2 per cent. solution, used as in purulent conjunctivitis.

Cleanliness and freedom from secretion are the indications, together with stimulation to enhance resolution. Boric acid, aristol, calomel, etc., are used as dusting-powders and also in the form of ointments. The *x*-ray has been employed with benefit.

**Follicular conjunctivitis** resembles an ordinary catarrhal conjunctivitis, with follicles in the retrotarsal fold and in the fornix. They are arranged in clusters or rows parallel to the lid margin. It is principally confined to the young, is said to be infectious, and appears

periodically. Some physicians make no distinction between this disease and true trachoma, but it is, without doubt, a distinct disease. It responds readily to simple treatment, while trachoma is most obstinate.

**Xerosis** of the conjunctiva is a dry condition, and is due to the action of a bacterium known as the xerosis bacillus. It is a short bacillus, often appears in pairs, end to end, sometimes broader at one end, and in many cases resembles the Klebs-Löffler bacillus.

The disease attacks those suffering from malnutrition. It is scarcely seen in robust animals. It accompanies other diseases—trachoma—and is nearly always present in wasting diseases, near the point of death, and in old and poorly fed beasts. It extends to the whole surface of the conjunctiva and both eyes are involved. There is a scanty secretion of a foamy nature deposited upon the margin of the lids and at their angles. This secretion contains the bacilli in large numbers. The character of the secretion, the dryness of the conjunctiva, and the loss of brilliancy to the cornea—which has a dull, greasy appearance—are the principal symptoms.

As the disease accompanies malnutrition, suitable tonics and a supply of sufficient food of a proper quality should be given. When it occurs with other diseases of the conjunctiva these should be met with proper treatment. In wasting diseases the condition is beyond repair, and death only relieves the victim.

**Membranous Conjunctivitis.**—This occurs in both man and beast. Fowls are particularly susceptible to it. It not only attacks the eye of the fowl, but also the mucous tract of the nose, mouth, and throat. This condition in the fowl is known by the common name of "roup," and is allied to diphtheria in the human family. The membrane is grayish-white, and in some cases is of a thick, yellowish, cream color. It is usually thick and tough, strongly adherent, invades the deep structures, and extends to the sinus about the orbit. The fowl is listless, often standing with its head drooped and unconscious of its surroundings. When the general system becomes invaded with the toxemia, the fowl refuses to eat or drink and much loss of weight takes place. If the eyeball becomes involved, as it often does, the loss of the organ follows. The membrane is so profuse as to protrude between the lids, and in one case the writer saw it perforated the upper lid, producing a large cicatrix after healing. It is said to attack choice varieties of fowls particularly.

Cats, calves, and sheep are susceptible to diphtheritic infection. There are forms of bacteria resembling so closely the true Klebs-Löffler bacillus it is with difficulty, and only by certain biologic tests or characteristics, they can be differentiated. In 1884 Löffler described two special types in animals—the Bacillus diphtheriæ columbrarum and the Bacillus diphtheriæ vitulorum. The former he obtained from the pseudomembranes

"in the mouths of pigeons, dead from an infectious form of diphtheria which prevailed in some parts of Germany among these birds and among chickens." The latter he obtained "from the pseudomembranous exudation in the mouths of calves suffering from an infectious form of diphtheria." Because these organisms differ in many respects from the true Klebs-Löffler bacillus, it does not indicate that they are less dangerous to man. We believe that this and many other diseases are imparted to the human being through the lower animals. For this reason, pet animals, when suffering with diseases of the eyes of a membranous nature, should be isolated from children, for these are the very parts handled and stroked by their innocent hands, and they unconsciously become infected by wiping their own eyes. The result may be a severe conjunctivitis of the child's eyes, possibly the loss of an eye, or even the loss of life. Law quotes several cases of infection of the human being from fowls suffering with membranous conjunctivitis. "Four attendants contracted the disease from sick fowls at a time when no other cases existed in the human population. Diphtheria prevailed in fowls, and soon, also, in those who fed them. A diphtheritic chicken conveyed the disease with fatal effect to a child which fondled it."

With this and other testimony in favor of the contagiousness of membranous affections of the conjunctiva of chickens, it is best to isolate them from the rest of the

flock, and also from members of the household, especially children.

There is a stage of exfoliation in which much of the membrane can be easily removed; but if this cannot be done without causing bleeding of the tissues beneath it should not be attempted. Numerous remedies have been recommended. Corrosive sublimate solution in 1 : 2000 or even 1 : 1000 parts has been used without injury to the cornea. Carbolic acid in suitable strength or a saturated boric acid solution is of value. Some use kerosene oil with good results. Antitoxin has been used satisfactorily. Give the chicken soft foods or milk, as grain causes irritation of the mucous tracts if the membrane has extended to the mouth and throat. With an ordinary chicken the best course to pursue is to cut its head off and bury it, but with a prize chicken of great value it is a different proposition.

**Pinguecula.**—This is a slight elevation of the conjunctiva or subconjunctival tissue, just a few millimeters from the internal border of the cornea. It was formerly supposed to be a fatty growth, hence its name. It is reddish-yellow in color, and at times becomes inflamed, when it causes much discomfort. Just what its cause is no one seems to know. Errors of refraction, dust, and strong wind are supposed to be the cause.

When in a quiescent state they are not troublesome, but when inflamed they are very annoying. Astringent

colleria are beneficial. If persistent they may be excised.

**Tuberculosis of the Conjunctiva.**—This appears ordinarily in the form of ulcers in the palpebral conjunctiva, though it may spread to the conjunctiva of the globe and even to the cornea. The ulcerated surfaces are covered with grayish-red granulations, about which are numerous nodules. The whole lid becomes affected in severe cases.

The disease may be primary and only affect one eye, though it often accompanies or leads to general infection. The neighboring lymphatics are usually involved. The cause is local infection, and it is nearly always confined to the young.

Excision of the ulcers, followed by the use of the actual cautery, is the best treatment. Iodoform, in powder or ointment, is of value, and good results have followed the injection of tuberculin.

**Pterygium.**—This is an encroachment of the conjunctiva of the globe upon the cornea. Its usual site is at the inner margin. It may be unilateral or bilateral. The growth extends in some cases over the pupillary area. It is said to arise from a pinguecula and exposure to strong winds.

As a rule it is not inconvenient, unless it has made much progress over the cornea, when symptoms of irritation and traction occur. The vascularity and thickening of the tissue are usually great, though in some cases

the growth is extremely thin and only slightly vascular. If much traction is made the movement of the eyeball is interfered with, and astigmatism may result or even diplopia.

The true pterygium is loosely adherent except at the apex, and, being folded in upon itself at the corneal margin, a probe may be passed beneath it to the fold at this point. This serves to distinguish it from a false pterygium—one caused by injury. The latter is strongly adherent all along its course.

The only thing to do is to excise them. There are several methods, but the simplest one is as follows: Grasp the apex of the growth with a delicate forceps, and dissect it carefully to the corneal margin; then make a V-shaped excision of the pterygium—the apex of the V toward the inner canthus. Undermine the conjunctiva so that the remaining edges can be drawn together by sutures, using care that it does not overlap the cornea. Precede the operation with the usual antiseptic precautions and two or three applications of a 5 per cent. solution of cocain. Some cases recur.

**Foreign Bodies in the Conjunctiva and Cornea.**—Vegetable substances are commonly found in the folds of the conjunctiva, such as seeds, particles of hay, barbs from grain heads, etc. The writer saw a small seed which had caught in the conjunctiva, had become covered with mucus, and, when removed, was in a state of ger-

mination. Chips or twigs of wood, bits of stone, and grit are often found in the eyes of animals.

Pain with increased lacrimation, redness of the conjunctiva, and sensitiveness to light are the principal symptoms. If the body is located on the conjunctiva of the upper lid the act of winking brings it in contact with the sensitive cornea and causes increased pain. The tears flow over the cheek because there is a greater quantity secreted than the little ducts can take care of. If allowed to remain, the cornea becomes irritated and scratched, and ulceration of this body may arise. If the foreign body is on the cornea the conjunctiva of the upper lid becomes irritated and inflamed by reason of the friction, and a catarrhal or purulent conjunctivitis may follow.

The nictitans membrane is a wise provision for the spontaneous removal of foreign bodies and the protection of the anterior portion of the eye. The retractor muscle acts as a protector from advancing injury by drawing the eyeball backward. The lashes have the function of catching dust and small objects that would otherwise enter the eye and cause inflammation.

*Treatment.*—The principal object in treatment is to find the foreign body and remove it. This should be accomplished with some degree of nicety. If it cannot be readily seen, evert the lower lid by making traction downward with the thumb. If it is still not seen, grasp the upper lashes with the thumb and index-finger, and

place the index-finger of the other hand, or a probe, about midway between the margin and the upper portion of the lid, as a fulcrum, and lift the lid upward. This will evert the lid and it can easily be inspected. If a foreign body be seen, wet with an antiseptic solution a small piece of cotton, and, after squeezing out the excess of fluid, wipe away the body. Sometimes the foreign body may become lodged in the retrotarsal fold; in such cases make a small swab by twisting a piece of cotton on the end of a probe, wet this and sweep it under this portion of the lid, when it will be dislodged. The foreign body may be hidden in the folds about the inner canthus and nictitans membrane, when only the most careful search will reveal it.

When a foreign body is on or embedded in the cornea it requires the most careful treatment. First, try a small piece of cotton, well twisted and free from loose fibers, and quickly wipe over the body, when, in many cases, it will become caught in the cotton and removed. It if cannot be readily removed by this method, use a 5 per cent. solution of cocain, and with a small knife-needle gently prick about the body and remove it, doing as little damage to the corneal epithelium as possible. If the epithelium is much roughened by this operation, smooth it gently with an eye spatula or the smooth, rounded portion of a shell spoon. Of course, strict antisepsis must be observed in all cases. The writer has seen severe corneal ulcers and loss of vision

from the careless removal of foreign bodies from the cornea.

**Burns of the Conjunctiva and Cornea.**—Horses attending fire engine companies, those used in warfare, and animals confined within burning buildings are liable to receive direct burns from firebrands, explosions, etc. Chemical burns are caused by strong corrosives, such as lime and acids, splashed into the eye.

According to the degree, the symptoms vary from a mild redness of the conjunctiva to a complete exfoliation of this tissue. It may be confined to a small area or engage the whole conjunctiva and cornea. Pain is always present. In some cases the conjunctiva is grayish-white in color, particularly during the stage of sloughing. The cornea is nearly always involved in severe cases, and becomes opaque, like ground glass in appearance, and the return to its normal transparency depends upon the depth of the burn. The subsequent effects of a burn of the conjunctiva and cornea are always to be dreaded, although the immediate symptoms may not appear to be profound. For this reason one should be guarded in his prognosis. Adhesions, either partial or complete, may take place between the conjunctiva of the lid and that of the globe, causing limited motion. The cornea also may be permanently opaque and blindness follow.

As the pain at first is intense, a drop of a 5 per cent. solution of cocain applied to the conjunctiva, with ice-

cold compresses over the lid, will allay it sufficiently to make an examination. Carefully remove any foreign substances and flush the eye with sterile water or boric acid solution. If the burn is caused by a strong caustic, neutralize it with a suitable solution. Olive oil, with the alkaloids of atropin and cocain, are of value in relieving pain, putting the accommodation to rest, and preventing adhesions by allowing the lid to play more freely over the globe in the act of winking. An adhesion (symbleph-

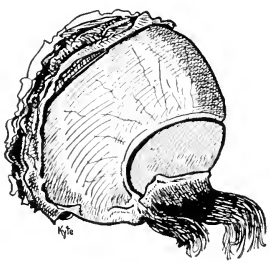

Fig. 22.—Dermoid cyst from original specimen.

aron) may be prevented to a great degree by daily breaking it with a small blunt probe. If extensive adhesions occur, surgical treatment is necessary.

**Tumors of the Conjunctiva.**—These are benign and malignant. The former interfere with the function of the eye by pressure. The latter usually cause the loss of the eyeball, and may endanger life by extension.

The principal *benign tumors* are polypi, cysts, lipomata, and granulomata.

A *polypus* is a pear-shaped tumor, pale and red in

color, bleeds easily by friction, and is found usually in the region of the caruncle.

A *cyst* may arise as the result of an injury, or "may form from dilated blood-vessels or lymph-vessels, or from the sac of a cysticercus cellulosæ." A type of cyst sometimes seen at the junction of the cornea is called a dermoid cyst, and is always congenital (Fig. 22.)

A *lipoma*, or fatty tumor, is a congenital growth, and is seen under the conjunctiva, usually in the upper and outer portion.

A *papilloma*, or warty growth, is more frequently seen springing from the margin of the conjunctiva and lid.

A *granuloma*, known commonly as "proud flesh," is the result of traumatism, and usually springs from the point of injury. It is often seen at the mouth of a sinus, and should not be confounded with a pathologic growth. It is simply an excess of healthy tissue and may be excised.

The principal *malignant tumors* are the sarcomata and carcinomata.

A *sarcoma* may grow from any point of the conjunctiva, but usually the seat is near the margin of the cornea. It bleeds easily because of its great vascularity, and is often pigmented.

A *carcinoma*, or cancer, is not infrequently seen in the region of the above tumor. It becomes papillomatous in its appearance and is devoid of pigment. In course of

time its malignancy is marked and destructive processes ensue.

The treatment of all tumors is a complete excision of all the tissue involved. The malignant types often require an enucleation of the eyeball, and in some cases all the tissues in the orbit must be removed (exenteration).

**Inflammation of the Nictitans Membrane.**—This occurs often in conjunction with conjunctivitis, though it may occur without inflammation of adjacent structures. The membrane may be only slightly inflamed, or it may become severely inflamed, swollen, and edematous to such an extent as to completely cover the cornea. It is usually due to traumatism. It often becomes chronically hypertrophied, which greatly interferes with its function and the closure of the lids, and when the advancement is very great it covers the pupillary area and shuts off vision.

The excision of this body should be the last thing resorted to. Keep the eye clean with antiseptic and astringent washes and use antiseptic ointment for lubrication. Be particular to examine the body carefully for foreign bodies which may be lodged within its folds or beneath it. Hot applications every two or three hours are beneficial, followed by astringent colleria. If, after diligent treatment, the body remains hypertrophied, that portion externally may be excised, being careful to leave that part of it that sweeps over the

cornea, together with the muscles that control it. After such an operation contraction readily takes place, and, as a rule, it resumes its normal size. In cases of edema only several punctures in the outer portion allows the escape of serum. This should be followed by cold applications frequently applied.

Edema of this body, together with the conjunctiva of the globe, is often symptomatic of some remote trouble, such as purulent inflammation of the orbital tissues or the hidden sinuses. In the former case there is more or less proptosis or bulging of the globe.

The membrane is sometimes drawn over the cornea spasmodically in cases of tetanus.

## CHAPTER VIII

### DISEASES OF THE CORNEA

The cornea is one of the most important structures of the globe. It is perfectly transparent, and is one of the refractive media next in importance to the lens. Diseases of this body, resulting in opacity, cause a greater percentage of blindness than diseases of all other portions of the eye combined.

It is composed of five layers, and a knowledge of these layers (see Anatomy), with the ability to distinguish the seat of the disease, will assist one materially in his prognosis.

**Keratitis** is an inflammation of the cornea. It may be local and confined to a small area, or it may be general, involving the whole corneal structure. Superficial keratitis, in which the epithelium only is involved, may undergo complete repair, with much damage to the refractive value. When Bowman's membrane is destroyed it is never replaced. When localized destruction of the true corneal layer occurs it is filled in by cicatricial tissue quite different in arrangement from normal elements.

In severe types of keratitis there is also a congestion of the conjunctiva, and often an inflammation of the iris

and ciliary body, with an exudate in the anterior chamber. This exudate may be purulent in character, when it is called a hypopyon. The amount varies from a slight line, which can barely be seen, to a complete filling of the chamber. The consistence of this exudate also varies from a thin, watery fluid to a thick, pultaceous mass. The former is readily absorbed, while the latter may undergo a fibrinous change and cause adhesions between the iris and the cornea.

Small spots of infiltration and superficial nebulæ can readily be detected by the use of oblique illumination and a magnifying lens. Dense opacities can easily be seen without these means. In a recent infiltration there is a dull and clouded appearance over the area. In case of an ulcer there is a loss of substance, seen in mild cases, by a break in a reflected line on the surface of the cornea. If the surface retains its luster the ulcer is a clean one, but if there is a cloudiness over its area, it is a foul or infected one. An opacity with a lustrous surface indicates an old ulcer which has healed in, leaving a cicatrix.

The symptoms of keratitis are essentially the same in all types. Pain, lacrimation, and photophobia are nearly always present. Reflex contraction of the lid (blepharospasm) is a common symptom, except in those cases caused by paralysis of the fifth and seventh nerves. In the former case there is no pain.

Keratitis is divided into two principal types—the

suppurative and the non-suppurative. The suppurative includes all ulcers, and those forms which are induced by infection from without. The non-suppurative type includes pannus, the vesicular and punctate forms, interstitial and all forms of keratitis, which are, as a rule, caused by constitutional disease.

**Ulcer of the Cornea.**—As the cornea is the most exposed portion of the eye, an ulcer is one of its most common affections. Ulcers range in degree from the simplest form, minute in size, to the destruction of a large area of corneal tissue, and their course is influenced, to a great degree, by the organism causing the ulcer, its early treatment, and the constitutional resistance.

Simple ulcers begin with a small infiltration, which eventually breaks down. They are usually clean, though they may have a slight grayish base. They may be irregular in shape, though usually circular. They have, under proper treatment, a tendency to heal readily without advancing.

In severe types the inflammation extends backward into the deep structures or spreads over a large area in the anterior layers. Deep ulceration may invade the whole thickness of the cornea. When perforation takes place there is a loss of aqueous with a prolapse of the iris into the wound. This remains impacted, and becomes adherent at the point of prolapse. At this stage resolution usually begins, and there is a gradual filling in or restoration of tissue, later marked by the presence

of a cicatrix or scar, which is opaque. If the perforation is not over the pupillary area it does not materially interfere with vision except by traction upon the iris over the point of prolapse, which causes a dislocated pupil to the point of prolapse or adhesion. If perforation occurs over the pupillary area a permanent fistula may be the result, or the anterior capsule of the lens may be drawn into the wound and an adhesion takes place. An opacity then occurs at this point which interferes with vision very greatly, as it is directly in the central field.

*Causes.*—Traumatism is the most common cause, such as the presence of a foreign body or the careless removal of one, followed by infection; scratching the cornea by a twig or whip; a misdirected eyelash; a burn, or an injury which breaks the epithelium and carries infection with it, or later becomes infected. Infection is the ultimate cause of all corneal ulcers. When free from infection much mechanical injury of the cornea may be done without purulent inflammation following. Exposure keratitis, followed by ulceration, may be primarily caused by lagophthalmus, exophthalmus, and paralysis of the fifth nerve. Purulent diseases of the conjunctiva and lacrimal apparatus, cow-pox, influenza, and other infectious diseases are common causes. The streptococcus, staphylococcus, pneumococcus, and other pyogenic bacteria are the infecting agents.

Some types of ulcers are more severe than others; they have special characteristics and are known by special terms.

The *crescentic ulcer* occurs near the limbus or sclerocorneal margin, and from its location is also known as marginal keratitis. It begins as an interrupted line of infiltration beneath the epithelium. Small pustules arise along its course, which coalesce. The epithelium soon breaks down and a continuous ulcer results. As a rule it is confined to the superficial layers and may spread to the center of the cornea, leaving in its wake a thin cicatrix. It may terminate favorably in a few days, though its progress is often protracted, and months may elapse before recovery takes place. It most frequently occurs in the aged.

*The Serpiginous Ulcer.*—This is one of the most destructive types of sloughing ulcer. It is characterized by a grayish-yellow disk-like patch, centrally located, with an opacity about the border and somewhat elevated. Numerous radiating striæ invade the corneal surface; the anterior layers break down and eventually a large ulcerated area filled with pus results. There is usually much pain connected with it in and about the eye, though in some cases the pain is not so intense as the pathologic process would lead one to believe it might be. Iritis and iridocyclitis with hypopyon very frequently occur. In many cases the ulcer perforates the cornea, allowing the escape of aqueous and pus.

The pus in the anterior chamber does not come from the cornea, but from the inflamed condition of the structures within the globe. When perforation takes place the severity of the central portion subsides, though destruction of the tissue may proceed along the borders until the whole cornea has become destroyed. Perforation is followed with a prolapse of the posterior structures; the iris falls into the opening, or, if exactly central, the lens capsule may fill the perforation and become adherent. After perforation, healing takes place much more quickly, though there is a scar left which is opaque and interferes with vision. In extremely severe types purulent inflammation of the uveal tract occurs, the eye is lost, and shrinking of the globe follows.

A *purulent ulcer* is any ulcer which rapidly or slowly sloughs. It is due to the entrance of pyogenic bacteria following an injury to the cornea. The progress invades the deep corneal layers at the point of commencement and a rapid destruction of the tissue follows. Early treatment should be employed in order to save the eye.

*Hypopyon* is pus in the anterior chamber. It gravitates to the lowest portion of the chamber; and if fluid in character it changes its position upon movements of the head.

*Treatment of Corneal Ulcers.*—The treatment of all ulcers of the cornea must be prompt, and energetic measures employed. If the ulcer is a small one and apparently clean, simple antiseptic washes may be used,

followed by the yellow oxid of mercury ointment to promote healing. One of the best mild antiseptic washes is the saturated solution of boric acid with a little astringent added. Zinc sulphate is usually employed for this purpose in the strength of ½ to 1 grain to the ounce.

If the ulcer is a foul one, that is, filled with purulent matter, the object in treatment is to kill the bacteria causing it, and at the same time to prevent its advancement. Cureting the ulcer to the healthy tissue was formerly employed, and in some cases is a valuable procedure if done by experienced hands; but much care must be used, or more damage than good will be done by the use of the curet. One of the best cleansing agents is one of the new silver salts, either argyrol or protargol, from 10 to 50 per cent. solution. It is well to use the stronger solution at first, gradually reducing the strength as one gets results. This should be dropped into the eye, and soon washed away with the purulent matter which the silver salt has coagulated. This operation can be repeated every one, two, or three hours, according to the severity of the case; between times wash the eye freely and frequently with a saturated solution of boric acid.

If the ulcer does not respond to this treatment, but rather increases in size and depth, touch it slightly with the strong tincture of iodin. As this is exceedingly painful, it should be preceded by the application of a 5 to 10 per cent. solution of cocain dropped on the cornea.

Sharpen a matchstick or wooden toothpick, wind a small piece of cotton on this so that it will point sharply beyond the point of the stick, dip it in the iodin tincture, but do not have so much on the cotton that it will drop or run. Hold the lids well open, and paint the surface of the ulcer, using care that none touch the other portions of the cornea. Keep the lids open a short time until the alcohol has evaporated. This operation may be repeated every two or three days if necessary. Most admirable results have followed this method of treatment. The writer has used iodin-vasogen in place of the tincture of iodin in some cases with good results.

In place of the iodin, or in conjunction with it, after the immediate irritation has subsided, powders may be dusted into the eye. Iodoform is one of the best, either in full strength or mixed with equal parts of fine boric acid. This fills the ulcer, destroys bacteria, absorbs secretion, and has, to some extent, an anesthetic effect. When powders are used in the eye, the finest quality, free from lumps and foreign matter, should be selected. They may be used in a powder-blower or, better, dip a camels' hair brush into the fine powder, hold it in front of the eye between the thumb and second finger, and give it a quick strike with the index-finger, which will cause the powder to fly into the eye. Aristol and calomel are sometimes used in these cases.

Antiseptic and stimulating ointments are of much benefit after the sloughing process has subsided. Among

the best of these are the yellow oxid of mercury ointment, 4 to 8 grains to the ounce, or the red iodid of mercury ointment, 1 grain to the ounce. In all ointments for the eye the drug should be well incorporated with the base, and ground evenly and smoothly, as the smallest free particle of the drug will produce much irritation, the same as a foreign body. Iodoform is often used in the form of an ointment in strength of from 2 to 25 per cent. The base is often made of vaselin alone, but equal parts of vaselin and lanolin are better. In applying the ointments, place a piece about the size of a pea on the everted lower lid and draw the upper lid over it, after which use gentle massage over the closed lids. Ointments of standard strengths are now put up by supply houses in tube containers which are very convenient.

Heat is always indicated in ulcer of the cornea. This is best applied by pieces of cotton wrung out in boiling water and placed over the closed lids, as hot as they can be borne by the hand. In acute cases this should be done every hour or two, and before using other treatment.

Atropin should always be used if the ulcer is centrally located, but if it be near the margin of the cornea a myotic is indicated.

The eye should be protected with a pad, and if the ulcer is a deep one a pressure bandage should be used.

When rupture of the cornea seems inevitable the best method is to hasten it by a *Saemisch operation*. This is done by passing the point of a Von Graefe cataract

knife through the healthy cornea near the margin of the ulcer, pass it along horizontally in the anterior chamber, and cause the point to emerge through the healthy cornea near the opposite margin, cutting forward through the ulcer. This can be done under local anesthesia. Atropin should be used, so that the iris will not prolapse into the wound. This operation at once reduces the tension if there be any, and allows the escape of aqueous and pus from the anterior chamber. Under slight pressure and the continued use of atropin and antiseptics resolution sets in more readily.

When the pneumococcus, which is said to be the cause of serpigenous ulcer, is present, the antipneumococcic serum has been used with great benefit.

**Pannus.**—This is an affection of the upper and anterior layers of the cornea, characterized by an opacity of these layers, filled with numerous ramifying blood-vessels.

In mild types the affection is superficial to Bowman's membrane, but in severe types this membrane is destroyed and the cornea proper becomes invaded. It is due to friction of the diseased conjunctival surface of the lid, more particularly to trachoma, and to an extension of the pathologic process to the layers of the cornea.

The degree and rapidity of the disease may be so great as to involve the whole upper surface of the cornea, even encroaching over the pupillary area, and sometimes covering the whole corneal surface.

The characteristic radiation of the blood-vessels, its location, together with the presence of trachoma, serve to distinguish it from other diseases of the cornea.

When the lids are contracted and the palpebral fissure is lessened in consequence, the greater is the liability of its occurrence. The superficial type readily clears up under proper treatment, but the longer the disease prevails and the deeper the structures involved, the more certain will there be a permanent opacity.

*Treatment.*—The main indications are to relieve the pressure of the lids upon the cornea, and to treat the trachomatous disease of the conjunctiva as described under that head. The pressure can be relieved by dividing the outer tendon of the orbicularis muscle as follows: Pass the blunt end of the blade of a strong pair of scissors horizontally beneath the outer canthus, the other above, make one quick snip; at the same time keep the parts stretched with the thumb and forefinger of the other hand. If the result is unsatisfactory, divide the remaining strands with a small pair of scissors. Bleeding can easily be stopped by compression, and the wound heals rapidly. This operation is known as canthotomy.

If one desires to draw the wound together to obtain a permanent result, three sutures may be introduced horizontally, one through the conjunctiva to the extreme angle of the wound, the remaining two, one above and one below, at a point midway between the

first suture and the upper and lower inner angles of the wound, avoiding the deep structures. This operation is known as canthoplasty.

The red iodid of mercury ointment, 1 grain to the ounce, with a 1 per cent. solution of atropin, applied three times a day, is of great value, together with general cleanliness and the treatment of the lids.

If much opacity of the cornea remain, treatment as described under that head may be employed.

**Phlyctenular Keratitis.**—This is a vascular disease, and may appear on any portion of the corneal surface, but is more often seen at the limbus and associated with phlyctenular conjunctivitis, under which head it is described.

**Herpes Corneæ.**—This is a form of vesicular keratitis. It usually occurs in conjunction with herpes on other portions of the body or face, such as the lips, nose, forehead, and eyelids, more especially when these eruptions accompany or follow febrile diseases of the respiratory tract, such as influenza, pneumonia, bronchitis, etc. It is characterized by a vesicle—one or several—which is at first clear, but soon becomes cloudy or yellowish in color, eventually breaks down, and forms a corneal ulcer. Much pain and irritation attend it. The prognosis is good if carefully treated, but if neglected destruction of the cornea may occur by widespread ulceration. The treatment is principally symptomatic.

Herpes zoster also attacks the cornea. It is much

like the former, though more severe and protracted in its course, and the deep structures are more liable to become involved. One special feature is, the cornea is insensitive to touch. Holocain, in 1 per cent. solution, dropped on the cornea every two hours, is of great value, together with general symptomatic treatment.

**Dentritic Keratitis.**—This is a superficial type of keratitis characterized by branching processes. The branches have the appearance of a grayish elevated line of infiltration. The epithelium covering these branches soon breaks down, forming slight furrows. This may remain superficial in character, or it may invade the deeper structures of the cornea and result in perforation. The disease is said to be due to malaria, though it occurs frequently quite independent of malarial influence.

*Treatment.*—When malaria exists it should be properly treated. Dumb animals as well as man have this disease. Antiseptic washes and stimulating ointments, together with general treatment, is all that can be recommended. The disease is often very protracted in its course and seems to resist all treatment.

**Filamentous Keratitis.**—This is characterized by a mass of twisted thread-like growths from the corneal surface. They are composed of epithelial cells, which become elongated and have the appearance of fibrillæ. They often arise from the floor of an ulcer or from an abrasion of the epithelium. The number of the fila-

ments may be few or numerous. They undergo mucoid degeneration, and after one crop disappears, in a few days fresh crops appear.

*Treatment.*—As the disease occurs in debilitated subjects, tonic treatment as well as local should be used. Mild antiseptic and astringent washes and protection are sufficient in the majority of cases.

**Desiccation Keratitis.**—This is caused by want of proper lubrication and protection, by failure of the lid to cover the corneal surface, due to paralysis of the orbicularis palpebrarum muscle, to extreme exophthalmus or ectropion. The condition is confined to the superficial layers, though in neglected cases the deep layers become involved, including the iris and ciliary body.

*Treatment.*—When the muscle is paralyzed, the lids can be brought together and retained in that position by the aid of adhesive plaster. This affords the natural moisture to the cornea, and with proper stimulating ointments the advancement of the disease can be aborted. In the case of extreme exophthalmus very little can be done except to treat the cause of the proptosis and apply lubricating ointments and oils to prevent the cornea from becoming dry. Ectropion must be treated surgically.

**Neuroparalytic Keratitis.**—This is much like desiccation keratitis, except that the former is due to want of protection, while the latter is due to insensibility of the

cornea and adjacent structures by reason of disease of the fifth nerve. The cornea is not sensitive to the presence of dust and foreign bodies, the reflex secretion of the lacrimal gland is interfered with, and the act of winking is lessened in frequency; hence the cornea becomes dry, the epithelium eroded and subjected to the lodgment and growth of destructive bacteria, and loss of substance through ulceration is the result.

*Treatment.*—The treatment in this condition is obvious. Protection of the cornea is the principal indication, with the continuous use of antiseptic ointments. If ulceration has taken place the general treatment of ulcers and protection must be employed. The cause of the diseased nerve must also be looked for and treated.

**Keratomalacia or Xerosis of the Cornea.**—This is due to dryness of the cornea in conjunction with xerosis of the conjunctiva, under which head it is described.

**Staphyloma of the Cornea.**—This is a protuberance of the cornea produced by ulceration, perforation, and prolapse of the iris. It may be partial or complete; and in shape conic or hemispheric. The spheric form is more frequent, and includes a general bulging of the cornea, forming a sharp outline from the scleral margin. The wall of the staphyloma becomes very thin in places, showing the iris pigment, giving it the appearance of a bluish grape. In other instances the wall is thick and appears white or opalescent. Numerous blood-vessels

may be seen radiating over the surface. Cicatricial bands form over the point of perforation, causing a special thickening of the wall at that point. The anterior chamber becomes obliterated, as the iris is closely adherent to the posterior portion of the cornea.

Fig. 23.—Staphyloma of the cornea of the human eye. Prepared by the author. This condition was due to trachoma. To the right of the center of the cornea is the point of ulceration and perforation, with exudation and thickening. To the left the iris can be seen glued to the cornea, which is extremely thin. The light spot in the center is a bubble.

A *partial* staphyloma is confined to one portion of the cornea, is cone shaped, and has a white apex. The remainder of the cornea is clear. The iris is only adherent at the point of perforation. This usually produces dislocation of the pupil, and, with the irregularity of the corneal curvature, interferes with vision.

*Treatment.*—As ulceration of the cornea is the primary

cause of staphyloma, this should be treated according to the rules under that head. If the perforation occurs, a bandage should be applied with moderate compression, the bowels kept open, and any undue exertion prevented. When the staphyloma is complete the eye is of no practical value, though light may be perceived.

If tension is present in the early stages a small incision through the cornea, at its margin, may be made, which allows the escape of the aqueous, reduces the tension, and encourages the reduction of the thin wall. The eye should then be protected with a bandage with gentle pressure. When the eye has lost its function by reason of extreme staphyloma an operation may be performed for cosmetic purposes, as the condition is very unsightly; also to allow the lids to cover the globe more completely. The operation according to the method of De Wecker, known as ablation or excision, may be employed. The conjunctiva is first divided around the limbus, undermining it some distance from the margin, threads are then passed through the upper and lower portion of this tissue, so that it may be drawn together much like the mouth of a tobacco pouch. The staphyloma is then abscised, beginning at the lower margin with a cataract knife and finishing with curved scissors. Through the upper and lower margins stitches are placed for the purpose of drawing it together, but before doing this the lens is removed after incising its capsule. The corneal sutures are then

drawn tightly and tied, and the whole covered by the conjunctiva by tightening and tying the puckering threads. The excision should be performed so as to get a transverse closure and as near the center as possible, to avoid irritation in the act of winking.

**Keratectasia** is a protrusion of the cornea following a keratitis without perforation, though the cornea has become thin by destruction of the superficial layers and offers little resistance to intra-ocular pressure. It differs from a staphyloma in that the iris is not involved.

An incision through the cornea at the margin, followed by a compress bandage, is of value, though if tension persists an iridectomy should be done, not to reduce the tension alone, but for visual purposes as well.

**Keratoconus,** or **conic cornea,** resembles keratectasia in some respects. It is not due to an inflammatory process, however, and does not become opacified. It is caused by a thinness of the corneal layers which yield readily to the pressure within the globe, causing the cornea to assume a clear cone shape.

**Keratoglobus,** also called **hydrophthalmus** and **buphthalmus** (ox eye).—In this case there is not a protrusion of the cornea alone, as in the preceding diseases, but rather an enlargement of the cornea in keeping with the general enlargement of the globe. It is congenital, as a rule, or appears in early life, and is said to be analogous to glaucoma in later life. The coats

of the globe are thin, and the pigment can be seen through the sclera, giving it a bluish appearance. The tension is increased, and when this subsides the disease ceases; but, if the tension continues, the disease goes on to ultimate blindness. Both eyes are affected. It

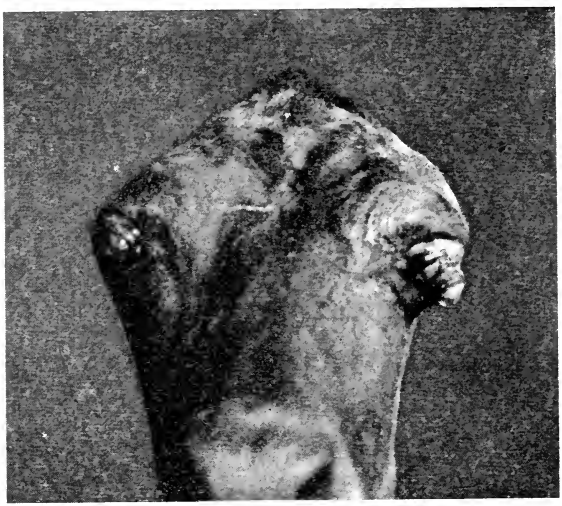

Fig. 24.—An extreme exophthalmos or protrusion of the globes, more marked in the left, due to an abnormal fatty growth in the orbits. Notice the opacity of the cornea from exposure.

is said to be hereditary, though the exact nature and cause of the disease is not fully understood.

**Opacities of the Cornea.**—Opacities are the result of ulceration or disease of the true corneal layer. They may be small or large, thin or opaque, according to the extent and depth of the disease.

Opacities are usually divided into three degrees:

first, a nebula, which is a slightly clouded patch; second, a macula, a somewhat denser patch; and third, a leukoma, a dense opalescent patch.

If the opacity is not over the pupillary area it does not materially interfere with the vision, but if it be centrally located vision of the central field is destroyed.

*Treatment.*—As the opacity is composed of cicatricial tissue quite different in structure from the normal elements of the cornea, it is impossible to reproduce a perfect transparency, though in some cases the results are surprising when proper treatment is employed. The following remedies are useful: Dionin, in solution of 5 to 10 per cent., or in the form of the powder, is probably the best. Begin with 5 per cent. solution and drop into the eye three to five times a day. This at first produces an extreme reaction, and causes the conjunctiva to become very red and edematous. When this takes place, use it less frequently. The reaction subsides in a day or two, and, after using the dionin a few times, it ceases to have this effect, when a stronger solution may be employed. In conjunction with this use the yellow oxid of mercury ointment in the eye three times a day, followed by massage. An ointment of thiosinamin, 10 per cent., is also recommended. The results are due, in great part, to massage used with the applications. Massage alone has been followed with excellent results. One must have patience in the treatment of opacities, as

it takes a long time to accomplish any degree of clearness. When the opacity is centrally located, and it cannot be made clear by medication, an iridectomy may be done for optical effect.

**Interstitial Keratitis.**—This is also known as parenchymatous keratitis, keratitis profunda, and keratitis diffusa.

It is essentially a disease of the young, and the usual cause in man is hereditary syphilis, though it frequently occurs in dogs as a result of distemper. It may begin at the center or margin of the cornea, as a grayish macula located in the stroma. This gradually extends until the whole cornea becomes invaded, and the tissues become opaque and assume a ground-glass appearance. On close inspection vessels may be seen ramifying through the deep layers, while some have tuft-like branches near the margin. The disease is very protracted in its course, and one or more months may elapse before it has reached its height, when the severity of the symptoms will gradually subside, and it may then require months before the cornea will resume its normal transparency; and there is a probability that it will never become transparent again. In some cases the disease is more localized and confined to small areas. As a rule the vascular condition exists in proportion to the extent and degree of infiltration. There are non-vascular forms, however, in which very few vessels can be seen. Being confined to the stroma,

ulceration does not occur, nor does purulent disintegration follow, as in the superficial types of keratitis.

The general symptoms of keratitis accompany the interstitial type—viz., pain, lacrimation, and photophobia. In severe cases iritis and inflammation of other portions of the uveal tract occur. The fellow eye becomes involved sooner or later, and when syphilis is the cause the knee-joints may become swollen and tender to pressure.

*Treatment.*—When caused by specific disease, constitutional treatment must be employed. Locally, relieve the eye of any undue irritation from strong light, etc. Atropin should be employed to give the accommodation rest and relieve or counteract a possible attack of iritis. Should iritis arise, dionin may be used in conjunction with atropin, and later the yellow oxid of mercury ointment added to this treatment, to promote absorption and assist in clearing the cornea of remaining opacities. Should conjunctivitis exist, as it often does in the case of distemper, this should be treated on general principles.

# CHAPTER IX

## DISEASES OF THE IRIS AND CILIARY BODY

THE *structure* of the iris is practically the same in all animals, though the arrangement of the muscle-fibers differ somewhat. For example, the pupil of the horse is elliptic horizontally, while that of the cat has the appearance of a vertical slit during contraction. The corpus nigra, suspended from the upper portion of the horse's pupil, has the appearance of a pathologic tumor.

The *color* depends upon the amount of pigment present in the posterior layers and in the meshes. Some animals—white rabbits for instance—are devoid of pigment and the irides are of a pinkish color. In horses this is occasionally seen as a partial defect, a portion only of the iris and adjacent structure appearing white or pink. It is not unusual in the human family to see persons with little or no pigment in the irides, and when such is the case the hair and other portions of the body are lacking in this element. Such persons are known as "albinos." An unequal amount of pigment in each iris causes one to look blue and the other brown or black.

**Congenital defects** of the pupil are often noticed, and one of the most common is a *persistent pupillary membrane*. It is common in man, and has been seen in the horse, ox, dog, and rabbit. Youatt mentions a case of congenital blindness from this cause in a female pointer eight weeks old (Steel's "Diseases of the Dog"). "Meyer notes the case of a congenital double pupil in a horse; a bridge extending across the space from the upper to the lower border, and cutting off the outer third of the opening" (Law's "Veterinary Medicine"). *Ectopia pupillæ*, or displacement of the pupil, is not uncommon, and frequently accompanies luxation of the lens. *Coloboma* of the iris is a condition in which a portion of the iris is absent from the border of the pupil to the periphery, causing a large, irregular opening. *Aniridia* is a condition in which the iris is absent. These congenital defects should not be confounded with pathologic conditions following iritis, injuries, etc.

The *size and shape of the pupil* vary in different animals, and are influenced by light, darkness, accommodation, medication, and disease.

**Mydriasis,** or dilatation of the pupil, is due to paralysis of the third nerve, irritation of the ciliospinal center, constitutional diseases, diseases of the central nervous system, contusions, intra-ocular pressure, and certain drugs known as mydriatics.

**Myosis,** or contraction of the pupil, is caused by paralysis of the cervical sympathetic, tabes dorsalis,

inflammation of the iris, foreign bodies on or in the cornea, and certain drugs known as myotics.

W. B. Coakley[1] has noted pin-point contraction of the pupil as a pathognomonic eye-symptom in rabies. "The contraction is so strong as to resist the effect of mydriatics." He further says, "A contracted pupil which yields to mydriatics is sufficient to exclude hydrophobia. There is medium dilation immediately before death." In the same article he notes that "alcohol, opium, morphin, codein, carbolic acid, eserin, and chloral, all of which contract the human pupil, were given to dogs in lethal doses without producing the myosis noted in rabbits."

**Iritis,** or inflammation of the iris. The iris is practically an extension of the anterior portion of the ciliary body, and we will consider them together. The relation of the blood-vessels and their source must be kept in mind, as those of the chorioid ciliary body and iris are intimately associated, and a knowledge of their arrangement is necessary when we come to consider inflammation of these structures, as it is rather exceptional for the iris to be inflamed when the ciliary body is not more or less involved.

An iritis may be mild or severe in type. The iris becomes hyperemic, the blood-vessels dilated, and a change of color from that of the other iris takes place, according to the amount of inflammation present.

[1] Medical Record, July 6, 1907.

This change of color is not as marked in dark-colored irides as in those of a lighter color. A bluish iris becomes greenish in color. The iris loses its luster and its fine lines are less distinct. If this hyperemic condition goes on to a more severe type of inflammation, exudation occurs and the iris becomes muddy in appearance. This exudation is composed of leukocytes and other inflammatory débris which settle to the bottom of the anterior chamber, where it may be seen as a whitish line, and varies from one barely visible to one filling the chamber. The more of this exudate there is present, the more clouded the iris appears. Not infrequently the blood-vessels rupture, and the blood settles in the most dependent portion of the anterior chamber, as does the exudate. Blood in the anterior chamber is called hyphemia. The exudate is often deposited on the posterior surface of the cornea and the anterior surface of the lens' capsule, which produces a grayish appearance to the pupillary area. It sometimes undergoes a fibrinous change, and the pupillary area is occluded by an apparent membranous formation.

In types of a mild, slow, chronic nature, and more particularly when the uveal tract is involved, the exudate may be seen by the aid of a strong lens deposited, as pin-point dots or larger, on the posterior layer, even when, to the unaided eye, it may appear clear. This precipitates to the bottom of the anterior chamber and forms a pyramid mass. That thrown out

from the posterior pupillary border assists in cementing the border of the pupil to the anterior capsule of the lens, either partially or completely. These adhesions are called posterior synechiæ. When the iris is completely adherent it is known as seclusion of the pupil; when this occurs, together with the formation of a membrane over the pupillary area, it is called occlusion of the pupil. When this takes place the eye becomes blind. Occluded pupil has frequently been found in the horse as a sequel of iritis.

An iritis and a cyclitis—iridocyclitis—often occur at the same time; however, an inflammation of one or the other of these bodies may be more pronounced.

*Cyclitis* is nearly always accompanied by tenderness over the ciliary region, and the congestion is more marked over this locality. According to Law, "it occurs in domestic animals, as described by Möller, but he fails to furnish instances of its diagnosis during life, and it is not likely to be recognized in living animals. Besides the usual signs of iritis, there is extreme tenderness on pressure around the anterior border of the sclera—it is quite likely to be complicated by suppuration and to go on to panophthalmitis."

*Symptoms of Iritis.*—Iritis is accompanied by pain, redness of the conjunctiva, small pupil, which reacts very sluggishly or not at all, discoloration of the iris, and the formation of synechiæ, which are more noticeable when a mydriatic is used. The tension is normal

unless secondary glaucoma (see Glaucoma) arises. Although pain is a symptom of iritis, it is not present in all cases, and the presence of iritis in some cases can only be determined by the use of the ophthalmoscope, when, after the use of a mydriatic, small pigment spots may be seen upon the capsule of the lens, near the pupillary margin, at the point where the iris has become agglutinated.

In the severe types the pain is almost unbearable, more intense at night, and it often radiates to the back of the head. The conjunctival injection is also very great, and if one is not on his guard he may mistake it for a conjunctivitis by "snap diagnosis." The course may be from one to several weeks. It frequently clears up, but may recur in the same or fellow eye.

*Secondary iritis* and *cyclitis* is the result of disease of the neighboring structures or injury. The injuries received by penetrating bodies in this region are the most apprehensive, more particularly if the penetrating agent is not sterile. Wounds of the ciliary region by infected bodies produce terrific reaction, as a rule often followed by loss of vision and suppuration of the uveal tract.

One of the gravest consequences of this condition is sympathetic involvement of the other eye—sympathetic ophthalmia—manifest at first by irritation, and later by inflammation of the iridociliary region, and eventually loss of that eye also. So that it behooves us to ex-

ercise the utmost caution, judgment, and care in our treatment of the primary cause.

Just how sympathetic inflammation is brought about no one seems to know definitely, but it is presumed to be effected through the lymphatic vessels or the circulatory system. Many a person has become blind in both eyes, which might have been otherwise had the injured eye been sacrificed in due season.

Whether the object remains in the eye or not, or whether this region has been simply pierced by a dirty instrument, the result is the same as a rule. No longer than six days should elapse before removing the offending eye, otherwise the fellow eye may become affected.

The iridociliary region is involved in all cases of recurrent ophthalmia of animals, and it is not uncommon to see the fellow eye follow in its wake; but, until we know more definitely what the exact cause is of recurrent ophthalmia, we are at sea as to the best method to pursue in preventing sympathetic involvement, as the cause in the second eye may be the same as in the first, and not sympathetic, as we understand sympathetic ophthalmia.

*Treatment of Iritis and Cyclitis.*—The treatment is constitutional and local. The cause should be sought and that treated. Influenza, tuberculosis, rheumatism, and other forms of infectious diseases are often the cause, and appropriate treatment is called for. Keep the animal quiet, in a dark stall, where it may be free

from the irritating effects of light, dust, dampness, etc. Open the bowels freely and keep them open, to relieve it from the absorption of toxins. See that the animal is kept under the best hygienic conditions. In debilitated subjects, tone up the system by the administration of suitable tonics.

*Local treatment* consists in preventing the formation of synechiæ, relieving pain, rest of the accommodation, depletion, absorption of inflammatory products, etc.

Atropin in solution is one of our best remedies in iritis. It paralyzes the accommodation, lessens the congestion, dilates the pupil, thereby preventing the formation of adhesions of the pupillary margin, and assists in relieving pain. In man it is used in 1 per cent. solution, but the solution must be graduated in strength according to the size and weight of the animal. The frequency of the application will depend largely upon the case. Usually three times a day is sufficient.

Dionin is one of the newer remedies, and, in conjunction with atropin, one of the best. It relieves pain and promotes activity of the lymphatic circulation. It acts better following the application of moist heat.

Heat, properly applied, is almost indispensable. A cloth or wad of absorbent cotton may be wrung out of boiling water, as dry as possible, and, when it can be borne, placed over the closed lids. This should be repeated every minute for six or eight times every hour. The eye should never be poulticed.

In cases of iridocyclitis, when the inflammation of the ciliary body is more pronounced, and in cyclitis pure and simple, atropin should be used with caution, as in many cases it is not well borne; besides, when this agent is used, the tension should be closely watched. Should any increase of tension occur the atropin should be immediately stopped and a myotic employed.

In severe cases of inflammation and congestion several leeches may be applied over the region of the temple. They assist greatly in reducing the inflammatory symptoms.

*Operative measures* should not be employed during the active stage of inflammation as a rule. *Iridectomy* may be done when the tension becomes increased, and it cannot be reduced by less radical means. When the pupil becomes secluded or occluded, iridectomy aids in re-establishing the natural drainage, and prevents, in a degree, subsequent attacks.

When tension develops, a *paracentesis* may be performed. It allows the escape of the aqueous, together with inflammatory débris, and assists in reducing the tension.

*Enucleation* should only be considered in infected traumatic cases when the fellow eye is in danger of sympathetic inflammation, and in cases accompanied or followed by suppuration of the internal structures, or when panophthalmitis exists, and the animal's life is

endangered by extension of the septic elements to the meninges.

**Cysts and Tumors of the Iris.**—Cysts of the iris are rare, though they sometimes appear in the stroma of the iris as the result of injury. They are usually very gradual in their development. Meyer (in Law's "Veterinary Medicine") speaks of these lesions in horses, "but they are very difficult to diagnose even with the aid

Fig. 25.—Photograph of carcinoma of the orbit of a dog. (Veterinary Record, vol. xvii, p. 694, "Proceedings of the Central Veterinary Medical Society.")

of the ophthalmoscope. The very manifest bulging at the part may be due to excess of pigment, especially in the corpora nigra, and an exploratory puncture would only be warranted when the protrusion becomes excessive and injurious. One such puncture by Eversbusch led to infection and loss of the eye." In this instance probably the puncture was not made under the strictest aseptic precautions. The treatment of cyst of the iris

is incision of the cyst at the corneal margin with a proper knife-needle. Of course, the same aseptic precautions must be observed as in all operative procedures.

**Tuberculosis of the Iris.**—This has occurred as a result of general infection in the smaller animals, and as a

Fig. 26.—Photograph of carcinoma of the orbit of a cat. (Veterinary Record, vol. xvii, p. 694, "Proceedings of the Central Veterinary Medical Society.")

spontaneous localization of disease in cattle. In Hess' case "the left eye was shrunken to half the size of the sound eye, and the small caseated nodules were present in both iris and chorioid." There are usually co-existing tubercles in other organs, and these, together with the nodular swellings of the iris, may assist in the diagnosis.

"Animals in which the eyes have been experimented on by inoculation die of general tuberculosis due to infection starting from the eye" (Duane).

**Tumors of the iris and ciliary body** are benign and malignant. The corpora nigra, which is normal, of course, is an example of the so-called melanomata which

Fig. 27.—Sarcoma of the left orbit. (Dr. Geo. H. Robberts' case.)

occur in the iris. It springs from the pigment layer at the margin of the pupil. Another form is an excess of pigment springing from the iris stroma and projecting into the anterior chamber. They develop to a certain size and may remain stationary. Portions of the pigment mass may become loose from the main body and fall into the anterior chamber. They are benign in

character, but must produce more or less irritation of the iris in its movements of contraction and dilatation.

*Sarcoma* sometimes makes its appearance independently in the ciliary body and iris, but is more often extended to these portions from primary affection of the

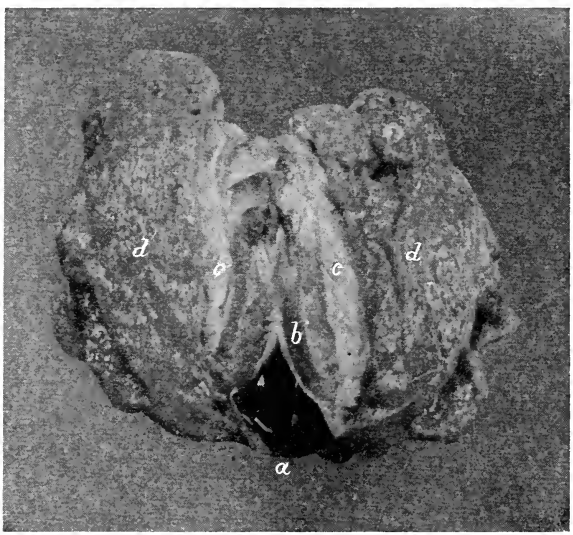


Fig. 28.—The contents of the left orbit in Fig. 24, cut in the center from above downward: *a*, the eyeball; *b*, the retractor muscle; *c*, the normal tissue; *d*, the tumor mass.

chorioid or the anterior portion of the eye. It is pigmented (melanotic), and when it is confined to the ciliary body it cannot be seen or discovered until it has reached a sufficient size, as the ciliary region is always difficult to see with the ophthalmoscope because it is located so far anteriorly. Its location may be deter-

mined with the transilluminator. This tumor is sooner or later destructive to the eyeball and possibly to life.

Fig. 29.—Melanosarcoma of the human eye. Prepared by the author. Notice the detachment and folding of the retina and the arched condition of the posterior portion of the lens which is pushed forward to the cornea, practically gluing the iris to it. This is due to the extreme intra-ocular tension.

The only thing to do is to enucleate the eye as soon as it is discovered.

## CHAPTER X

### DISEASES OF THE RETINA AND CHORIOID

DISEASES of these coats and also of the optic nerve are diagnosed by the use of the ophthalmoscope. This instrument is devised for throwing reflected light into the eye from a tilting mirror in front of a series of spheric lenses; a hole is in the center of the mirror, and the small lenses are protected by a circular revolving disk. Two methods of examination are used: The direct method, by which the physician looks directly through the hole in the mirror, the same being close to the animal's eye. The light (a candle is sufficient) is placed to the right of the animal's head if the right eye is to be examined, the ophthalmoscope being held in the right hand, and the examiner uses his right eye. In examining the left eye, hold the instrument in the left hand, and look through the hole in the mirror with the left eye. The light should be on the left side of the animal's head. When examining either eye the mirror is brought close to the eye of the animal, and so tilted as to produce a red reflex, when the fundus will be illuminated. If the vessels are seen, but are indistinct, the disk may be turned so as to bring out the vessels sharply by either

a plus or minus spheric lens. The numbers of the plus lenses are usually white, while those of the minus lenses are red. The examiner's eyes should both be open,

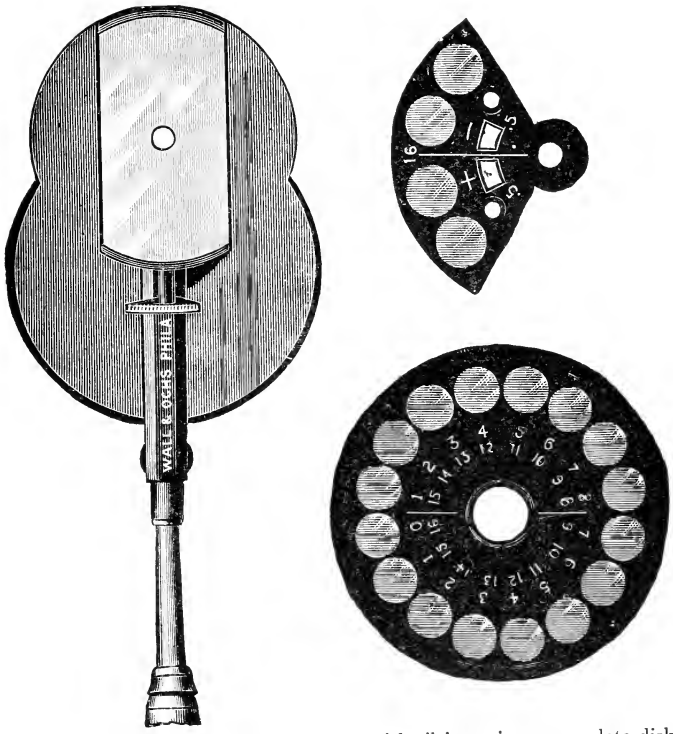


Fig. 30.—Loring's ophthalmoscope, with tilting mirror, complete disk of lenses from —1 to —8 and 0 to +7, and supplemental quadrant containing ±0.5 and ±16 D. This affords 66 glasses or combinations from +23 to —24 D.

and the accommodation relaxed, as in viewing objects through the microscope. The indirect examination is made at a greater distance from the animal's eye, and

with the addition of a spheric lens of about +16 diopters. In using this method the disk should be turned so that a +3 D. lens shows behind the hole in the mirror. Support the 16 D. lens with the thumb and index-finger of the right hand (for the left eye, and with those of the left hand for the right eye), and allow the little finger to rest upon the face near the eye, so as to guide the distance between the eye and the lens. The examiner will hold the ophthalmoscope close to his own eye, and pass the reflected light through the 16 D. lens near the animal's eye. This method gives a greater field, but a reduced image, and usually brings out the retinal vessels and optic disk distinctly, even in cases of a high myopia.

It will be well for the veterinary student to use the ophthalmoscope as much as possible in the examination of the eyes of various animals, and become acquainted with normal fundi. This is the only possible way to be able to distinguish a normal from a diseased fundus. Examine the human eye also, and study the difference in the structure of the coats and the arrangement of the vessels from those of dumb animals' eyes. (See Frontispiece.)

Normal fundi of animals of a kind are the same, though they may differ in degree of shade or color according to the amount of pigment. Anomalous conditions (such as coloboma of the chorioid or retina) may be mistaken for a pathologic change, but experience in

examination will teach one the difference. The tapetum lucidum may also be mistaken for a pathologic lesion. The brilliancy and varied coloring of this portion of the fundus is most interesting. A fowl's fundus distinctly differs from a quadruped's. There is a projection into the vitreous, known as the "pecten," said by some authors to be a projection of the chorioid, and by others to be a portion of the retinal circulation. It appears on cross-section of the eye to project from the optic nerve.

The retina, although histologically divided into ten layers, may properly be divided into tissues of two kinds—a nervous and a supporting tissue. It is said to be transparent, which is quite evident in fundi with little or no pigment when the outlines of the vessels of the chorioid can be seen through it. Its system of blood-vessels is particularly its own, as they do not anastomose with themselves or other systems of vessels except at the papilla, where there is a minute connection between the retinal and ciliary vessels.

The retina is subject to anemia, edema, hyperemia, hemorrhages, detachment, inflammation, and atrophy.

**Anemia** occurs with general anemia and follows severe hemorrhages from other portions of the body. It also occurs in compression and embolism of the central artery. There is a reduction in the caliber of the vessels and the retina is generally pale.

**Edema** is the result of traumatism and disease, and is due to effusion in the retinal tissues. It presents a

cloudy appearance, which may sooner or later clear away, leaving retinal change. It usually causes a reduction of sight.

**Hyperemia** accompanies inflammatory diseases of the retina and optic nerve, and, in man, a simple hyperemia is often due to eye-strain and excessive light.

**Hemorrhages** usually follow injuries, diseases of the blood-vessels, retina and chorioid, and sometimes take place when inflammation is not present. They occur along the course of a vessel and are irregular in outline. When they occur in the macular region the animal is blind in the central field. Sometimes large hemorrhages between the hyaloid membrane and the retina occur, which precipitate and form a peculiar shape (subhyaloid hemorrhage). When the blood is absorbed, which usually takes a long time, pigmented spots or atrophic white spots remain over the site.

**Detachment** is often due to injuries and diseases, which cause a fluid vitreous and loss of support of the retinal tissue, or to an accumulation of fluid between the retina and chorioid when the former is pushed forward. The detachment may be confined to a localized area, as it is at first, and may then become total. The visual fields are largely disturbed in partial detachment, and in total detachment complete blindness will follow.

**Retinitis,** or inflammation of the retina, is varied in appearance and cause. It is characterized by hyperemia and edema, indistinct outlines of the papilla, tortuous

veins, and, in many cases, numerous hemorrhages. White spots appear scattered about the fundus, due to the presence of exudates. These exudates often pass into the vitreous, causing opacities in this substance. The vision is reduced according to the site and degree of the inflammation, which is general, though it may be localized.

The appearance by ophthalmoscopic examination often depends upon the cause, though in many cases the cause is not easily found. Among the various causes are Bright's disease, diabetes, syphilis, diseases of the vascular system, and diseases of the blood.

The characteristic early appearance in Bright's disease is a radiation of white spots about the macula with occasional hemorrhages, and larger exudates in various portions of the retina, together with other lesions above described. This form of retinitis frequently[1] occurs in the bitch during the stage of pregnancy.

The only way to determine the cause of retinitis is to give the animal a thorough physical examination, including a chemic and microscopic examination of the urine and blood.

**Atrophy of the retina** often occurs as a result of a long period of inflammation, or the reduction of its nutrition

[1] There is one particular condition which is not infrequent and should not be mistaken as pathologic; this is a series of medullated fibers which appear like a white flame extending from the optic nerve upward and downward, or in one direction only. In such a case the general symptoms of retinitis are absent.

from embolism or thrombosis of its vessels. The latter become very small or obliterated, though the remaining portion of the retina may appear normal.

**Rupture of the retina** is the result of injuries, principally contusions of the eyeball. "Cases of isolated laceration of the retina are extremely rare. The retina is much harder to tear than the chorioid, since in rupture of the latter the retina is generally found to be uninjured" (Duane).

**Glioma.**—Because of the structure of the retinal tissue glioma is the only growth the retina is subject to. For a long time it has been known as "amaurotic cat's eye," from the fact that the eye is blind, and the fundus reflex looks like that from the tapetum of the retina of the cat's eye in the dark. A glioma is a very malignant tumor and occurs in the young. If not early removed, it soon extends to the optic nerve and brain and results fatally. Besides extending backward, it grows forward and laterally into the tissues of the orbit. The globe is much enlarged and ugly ulcerations may take place. It may attack one or both eyes. It is one of the most malignant and fatal diseases of the eye with which we have to deal.

### Diseases of the Chorioid

Because of the close connection with the retina these two coats are nearly always affected when one or the other is first inflamed. This is known as a retino-

chorioiditis; however, diseases of these coats do appear to exist independently, and when the chorioid alone is inflamed it is called chorioiditis. The distinction is made by the retinal vessels, without a break, passing over the chorioidal lesion.

The chorioid is a portion of the uveal tract extending forward and including the ciliary body and iris, and these bodies are often inflamed in conjunction with the chorioid, when it is known as iridochorioiditis. These are the parts first affected in recurrent ophthalmia.

The chorioid is a vascular and pigmentary coat, with supporting connective tissue, and is subject to simple and inflammatory affections. It rests upon the white sclera, and for this reason rupture of the coat can be easily seen, as can the crescentic rupture near the papilla in cases of high myopia.

The early stages of chorioiditis are manifest by various spots of a yellowish-white color due to exudates, when the retinal vessels may be seen passing over them. Later, by a proliferation of pigment, these spots appear black, particularly about the borders. There is always a disturbance of vision, with a sensation of flashes of light, with marked scotomata. The causes are syphilis, scrofula, tuberculosis, and diseases of the blood. In cases of high myopia the chorioid suffers many changes by reason of severe stretching.

According to the location and distribution of the spots or lesions, chorioiditis is known as central, disseminated,

and diffuse. If the macula does not become affected, central vision remains good. There is little hope of restoring the chorioid to its normal conditions, as atrophy of the affected areas usually follow.

**Purulent chorioiditis** is the result of infected wounds, ulceration of the cornea, and metastasis in cases of pyemia and septicemia. The whole uveal tract is usually involved. It may undergo absorption when the globe becomes shrunken. Panophthalmitis is a condition in which the globe ruptures in its orbital portion, affecting the orbital tissues; or purulent inflammation may originate in the orbit and perforate the coats of the eye.

In all the forms of optic neuritis, retinitis, and chorioiditis, except the purulent type and those associated with iritis, there is no pain and no external evidence of the disease. The diseases of the retina and chorioid are spoken of by some as "internal ophthalmia," but this term is indefinite, except to indicate an inflammation of the internal structures of the eye.

## CHAPTER XI

### DISEASES OF THE OPTIC NERVE

The optic nerve is subject to inflammation at any point along its course. When it occurs in the anterior portion it may gradually ascend along the trunk, and when the initial trouble is along the trunk it may descend to the optic disk, and will be followed by atrophy in many cases. When the disk is inflamed the retina is nearly always involved, when it is known as neuroretinitis. The causes are traumatism, inflammation of adjacent structures, tumors, hemorrhages, and diseases of the central nervous system. A portion of the fibers only may be affected, when vision will be partly retained, but if all the fibers are involved and atrophy follows, vision will be entirely lost. When one eye only is affected the cause lies anterior to the optic chiasm.

**Papillitis** is an inflammation of the optic nerve head or papilla. It is usually bilateral, and is due either to pressure upon the nerves or tracts or to effusion within the sheaths or fibers. The papillæ are edematous and swollen, larger than normal, and may be reddish, gray, pale, or even white, and the outlines are very indistinct. The arteries are small, while the veins are large and

tortuous. The disk appears "choked," and the tissues have a striated appearance from the center outward, extending into the retina. Vision may be normal in some cases, though a marked decrease in the fields and acuity of vision is the rule, and sudden blindness sometimes occurs. The prognosis is always grave.

**Retrobulbar neuritis** is inflammation of the nerve within the orbit, posterior to the globe. It is often caused by influenza and catarrhal disturbances of the nasal passages, involving the sinuses directly adjacent to the orbital tissues. It may occur in one or both nerves. Total blindness may follow an acute attack, caused by severe inflammation of the orbital tissues, though in the majority of cases only a varying decrease in the visual acuity is the result. The fundus is normal in appearance, though atrophy of the nerve-fibers may take place and descend to the papilla, when it will gradually become white. The prognosis is usually good if the cause is removed and the nerve-fibers toned by proper medication.

**Toxic amblyopia** is due to poisons within the system. In man, alcohol and tobacco are the principal causes, though lead, arsenic, and various other chemic poisons may be the cause. Quinin in large doses has produced it. "Anatomic investigations in quinin-poisoning, produced experimentally in dogs, shows during the very first days a destruction of the ganglion cells of the retina, these being primarily attacked by the poison" (Duane).

It is manifest by a gradual or rapid reduction in sight. The central field is the one involved, and from this fact it is possible that the poison may attack the nerve elements of the macula first and then recede to the optic nerves. Colors are not easily distinguished, especially red and green.

The *treatment* in such cases is to remove the cause, keep the bowels open, and tone up the nerve-fibers by the use of strychnin.

**Atrophy** of the optic nerve may be simple or inflammatory. In the former the nerve head becomes gradually white, without symptoms of inflammation accompanying it. The sight is gradually reduced until there is complete blindness. The principal causes are affections of the brain and tabes dorsalis (sclerosis of the posterior columns of the spinal cord). The author once saw a case of this kind in a cat in which both optic nerves were entirely atrophied, with sight and locomotion abolished.

Inflammatory atrophy is the result of optic neuritis, with symptoms like those described under Papillitis. After the swelling of the nerve head subsides the outline becomes more distinct and smaller in size, and the large and tortuous vessels become contracted. The papilla has a white appearance, sharply defined. The prognosis is always unfavorable.

The *treatment* should be aimed at the cause, together with tonics and alteratives for the nerve lesion.

It is of the utmost importance, in passing one's judgment upon the soundness of an animal, that the optic nerves be examined—in fact, the whole fundus of the eye; for, however sound an animal may be otherwise, if the fundus is or has been diseased, it materially lessens the animal's value. In order to determine a pathologic condition one must become familiar with the normal fundus, and advantage should be taken of every opportunity to learn its details.

## CHAPTER XII

### DISEASES OF THE LENS

**Cataract.**—A cataract is an opacity of the crystalline lens, its capsule, or both. Animals are as subject to cataract as man. The horse, dog, and cat are frequently seen with cataractous lenses.

Normally, the lens is transparent, but as one advances in life it becomes less transparent and assumes a hazy appearance when viewed obliquely. This is due to an increase in its density. Under this condition the vision is probably as good as in early life, when the lens is much softer, though often in man the density becomes so great that near-sightedness is developed by virtue of changes in its refraction. In such instances elderly people read print without the aid of glasses, and they think, as is often remarked, they have their "second sight." Such cases, however, are apt to be followed by cataractous changes.

*Classification.*—Cataracts are classified, according to age, density, course, etc., as congenital, senile, soft, hard, incipient, mature, primary, secondary, capsular, lenticular, stationary, progressive, traumatic, etc.

When an animal is born with cataractous lenses it is

the congenital type, and is due to faulty nutrition. A senile cataract occurs late in life when the lens becomes sclerosed, and is due also to faulty nutrition or to the absorption of toxins from the circulation; and here a toxic type might be mentioned, produced either by auto-intoxication or the ingestion of toxic agents, such as the ergot of rye, for example. Soft cataracts occur in the young and hard cataracts in aged subjects. An incipient cataract is one in its initial stage, before the vision has become impaired, while a mature cataract is a lens which has undergone complete change. This is also known as a "ripe" cataract, and is ready for extraction. A primary cataract is one that appears without apparent cause, while a secondary cataract follows disease of other structures of the eye, such as glaucoma, etc. Lenticular cataract is confined to the lens; it is also known as cortical or nuclear, according to the location of the opacity. When a cataract remains in the same condition for a long period of time it is said to be stationary. The posterior polar cataract is classified under this head, and also as congenital and capsular, and its cause differs from that of other cataracts. A progressive cataract is one that steadily advances to maturity. Traumatic cataracts are the result of either direct violence or accident during operations.

As a rule, a cataract does not lessen the vision unless it is centrally located. There is no inflammation present that is dependent upon a cataract unless it is com-

plicated with diseases of other structures. The size of the pupil is not affected unless iritis or glaucoma exist.

When a cataract occupies the pupillary area the color of the pupil changes from its dense black to a bluish-white or gray appearance.

In examining the lens for incipient cataract the pupil should be dilated by the use of atropin and illuminated by oblique light or the transilluminator, when spokes in the extreme border of the lens can be seen radiating toward the center. They can easily be seen through a strong lens by the aid of the ophthalmoscope.

A senile cataract usually begins in this way, by branching or spoke-like opacities radiating from the periphery.

As before mentioned, auto-intoxication has been hinted at as a cause of this type of cataract. The lens is a non-vascular body, and receives its nourishment from the ciliary processes through the circumlental space. It is suspended by Zinn's ligament, which not only fuses with the lens capsule, but apparently dips into the lens substance somewhat, producing a sort of serrated condition of the peripheral portion. It is at this particular point that the cataractous spokes appear to arise.

A cataract of the senile type is divided into four stages—viz., incipiency, intumescence, maturity, and hypermaturity or degeneration. Nothing of importance is noticeable during the first stage, unless it be com-

plicated with pathologic changes in the chorioid and retina. The lens during the second stage becomes swollen because it has absorbed fluid, and the iris is pushed forward in consequence, but not until the striæ reach the pupillary or, rather, central area, and the lens assumes a bluish-white color and becomes partially opaque, is vision disturbed to any great degree.

A gradual mersion from the second to the third stage takes place when the lens becomes totally opaque; the excess of fluid is lost and it resumes its normal size. During this stage there is no fundus reflex, the pupillary area appears white and the vision is nil, though, if there is no fundus disease, light may be perceived and also the direction from which it comes. This is known as light perception and projection, which might be difficult to obtain in the animal. The operation for cataract (extraction) should be done during this stage.

The fourth stage is indicated by a liquefaction of the cortical portion of the cataract by reason of fatty degeneration.

The nucleus, however, retains its hardness, and remains so for years, floating in the milky-like liquid of the remaining portion of the lens within its capsule. In many cases the capsule itself sooner or later becomes cataractous, and when this occurs an operation of extraction is liable to be attended with complications.

A secondary or capsular cataract often occurs after the extraction of the lens if an extraction is done

without removing the entire capsule at the time. Extraction of the lens in and with the capsule is practised by many operators, but with animals it would be a hazardous undertaking, as it requires much time, care, and special skill, besides there is greater danger of losing much vitreous and possibly the eye itself.

A capsular cataract is due to a proliferation of cells upon its surface and a thickening of the capsule, which does not occur until some time after extraction. It eventually diminishes the effect of the operation. In hypermature cataracts this change takes place in common with the degeneration of the lens substance.

In some instances a cataract will clear up spontaneously, though when it becomes complete there is less probability of it doing so. In traumatic cataract, when the lens is soft and the capsule is completely ruptured, so that the lens substance escapes, it is usually absorbed. This process of absorption sometimes takes place very rapidly, even within forty-eight hours after the injury. In traumatic cataract of old and hard lenses this ready absorption does not take place; on the contrary, the lens remains cataractous, and often swells to such a degree as to produce much increase of tension and severe pain, when immediate extraction is often necessary.

In the early stages of cataract massage over the closed lids has apparently benefited some cases, while in others it has seemed to create an increase in the

rapidity of the cataractous formation. Drops of various kinds have been placed upon the market which are claimed to promote absorption, but, having been tried by eminent men in the profession, they have been found to have no value in this respect. After a cataract has been formed there is no treatment except relief by operation.

**Luxation of the Lens.**—The lens becomes dislocated by reason of traumatism, extreme muscular exertion,

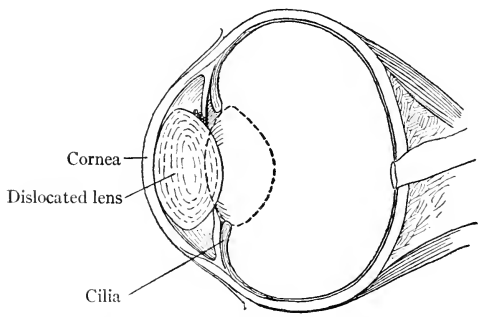


Fig. 31.—Vertical section of eyeball of horse, showing dislocated lens in anterior chamber. Dotted line indicates normal position.

sudden reduction of tension, extreme increase of tension, atrophy of the fibers of the zonule of Zinn, particularly in hypermature cataract. In short, by stretching or rupture of the suspensory ligament.

In cases of partial luxation the border of the lens may be tilted backward or forward. In complete luxation the lens may be forced backward into the vitreous, and in rare instances it is forced forward beneath the con-

junctiva. In man it has been driven through the coats of the globe into Tenon's capsule.

Luxation backward into the vitreous is the most common. It may remain there without causing any special reaction, though it frequently causes, in traumatic cases, hemorrhage and inflammation of the inner coats of the eye, eventually resulting in shrinking of the globe.

In a dislocated cataractous lens the treatment, in man, would be to allow the lens to gravitate into the anterior chamber, fix it with a needle, and extract it by the usual method, by passing a loop or wire spoon beneath it. This method would be impracticable in animals. One might attempt to fix the lens if it can be favorably placed and scoop it out carefully. An outer or inferior section should be made, as one has a greater field in which to work, and the wound can be more readily inspected and cleansed.

**Lenticonus.**—This is an anomalous condition, and has been found in the pig and rabbit by Hess, as described by Norris and Oliver. In each case the lens was without a nucleus and cone shaped, with the apex pointing backward. Although the anterior portion was clear with normal capsule, the lens substance had undergone granular degeneration. Several investigators have found this condition in the eyes of rabbits.

## CHAPTER XIII

### OPERATIONS FOR CATARACT

THERE are two principal operations for cataract—discission and extraction. The former is employed only in cases of congenital cataract, or when it is acquired in early life, when the cataract is soft and undergoes absorption readily.

**Discission of Cataract.**—The ultimate object of this operation is to produce absorption of the lens by breaking up its substance by the use of a small knife-needle. The eye should be washed with an antiseptic solution of bichlorid of mercury, 1 : 5000, and the pupil dilated with atropin solution of 1 per cent. It should then be anesthetized with cocain of 5 to 10 per cent. solution. The speculum may be used, or an assistant may hold the lids apart. The knife-needle is then passed through the cornea near its margin—never through the center—and pushed diagonally through the lens capsule and into the lens substance. An upward and downward movement of the handle causes the lens to be cut and broken. The knife-needle must be withdrawn in the direct line of its entrance.

If absorption of the lens substance does not readily

occur, this operation may be repeated; in fact, several operations may be necessary to produce complete absorption.

In some cases following discission swelling of the lens takes place, which causes pressure upon the anterior drainage canal (canal of Schlemm), producing an increased tension, often accompanied with much pain. If this persists after the use of ice-cold applications and rest, it may be necessary to make an incision of the cornea at its margin and allow the lens substance to escape. In severe cases of increased tension an iridectomy may be performed. Iritis of a severe type may be produced by irritation from floating particles of the lens. This must be met by the use of atropin and hot applications locally, purgatives, rest, and a dark stall.

**Extraction of Cataract.**—This operation is adapted for all hard cataracts, and for such as a discission would be deemed inadvisable.

Before attempting this operation, however, there are many things to consider. Should the fundus be diseased or the optic nerve atrophied, the operation would be of no practical value. To determine whether the fundus is normal the animal should be placed in a darkened room, the better eye covered, and light from a small mirror reflected on the eye being tested. Note the action of the pupil, and whether the animal notices the light as it is placed at various points of the fields—above, below, outward, and inward. If the pupil reacts, and

notice is taken of the movements of light by motion of the eyeball, it is fairly conclusive that the fundus is normal.

The conjunctiva must be free from secretion and the nictitans membrane and lacrimal apparatus free from hypertrophy and inflammation. In man the urine is always examined to determine the absence of albumin and sugar. The animal should be free from cough and any disease which may cause sudden exertion. The bowels should be freely opened the day before the operation.

Preceding the operation the conjunctival sac should be examined, and washed with a saturated solution of boric acid or a 1 : 5000 solution of corrosive sublimate. The long hair about the eye may be trimmed with scissors, and the parts washed with soap and water, followed with one of the above solutions.

In man we use cocain of about 5 per cent. solution, but in animals it is better to use complete general anesthesia, as any sudden movement during the operation may cause a serious accident.

The various steps of the operation are: Applying the speculum, corneal section, iridectomy, cutting the capsule, extracting the lens, cleansing the wound (toilet), applying the dressing.

Some operators prefer to use atropin previous to the operation to dilate the pupil. Some also prefer not to use the speculum, but rather to have a com-

petent assistant hold the lids open with the fingers or retractors. There are objections to this latter method, however, as the hands of an extra person are always in the way, and pressure upon the eyeball may be made, which must, in all cases, be avoided. The conjunctiva of the globe must be grasped with the fixation forceps at a point opposite to the corneal section. The Graefe cataract knife may then be passed in at the corneal margin, sliding it along through the anterior chamber, being careful not to wound the iris, and the counterpuncture made at a point directly opposite, at the margin; carry the blade forward, and with one sweep, if possible, complete the section, following the margin all the way as closely as possible. The success of this step depends upon two principal points—the skill of the operator and an exceedingly sharp knife. Each knife should be tested before the operation, and the point should pass through the test-drum head by virtue of its own weight.

In man the corneal section is usually made upward, passing the knife through the cornea from the external portion in each eye, making the counterpuncture toward the nose. A section of a little more than one-third of the cornea is usually made. It is better to make a large rather than a too small section, so that the lens can be readily extracted without undue pressure and wounding of iris and adjacent structures, when there is less danger of inflammation of these structures following,

also less danger of complications attending the operation. The section should be made by a pushing or pulling movement, with as little sawing motion as possible, as there is less danger of serration of the edges of the wound, and healing takes place more readily. When one considers the anatomic relations, it will be seen that the margin of the cornea must be closely followed.

**Iridectomy** is the next step, though this is omitted in simple extraction. With an iridectomy there is less danger of prolapse of the iris through the wound, and the lens is delivered more readily. On the other hand, the pupil is less regular and the vision may not be as perfect, though just as good visual results have been attained following an iridectomy as by the simple extraction.

Iridectomy is performed by passing a special iris forceps through the wound, grasping the pupillary border of the iris, withdrawing it through the corneal wound, and snipping off a small portion with a special iris scissors.

The next step is the cutting of the capsule. Some operators prefer to rupture the capsule by tearing out a portion with a special capsule forceps. A much better method is cutting out a square window by the use of the capsulatome. This instrument is passed in, pushed downward, then horizontally, then upward, then again horizontally to the starting-point. This square section often comes away with the lens, leaving a clear pupil.

The next step is the extraction of the lens. With a special spoon-shaped instrument make pressure over the cornea at a point about three-fourths of the corneal width, in the opposite direction from the incision. This causes that portion of the lens to tilt backward and the opposite portion to tilt forward and present itself in the wound. Counterpressure may be made with a small spoon-shaped instrument on the sclera, near the corneal section, allowing the lens to slide over this instrument, with which its delivery may be greatly facilitated by gently lifting it outward and upward, at the same time keeping up the pressure with the other instrument, gradually following the lens upward until its extraction is completed. Any remaining portions of the lens substance or capsule fragments may be teased out by the same method.

Protruding portions of the iris must be replaced with a small spatula with rounded edges, or a small shell-spoon, and all blood-clots and shreds must be cleared away from the wound, so that the edges will readily unite. The speculum may then be removed and the eyelids closed. A sterile dressing and bandage must then be applied.

*Accidents Attending the Operation.*—Numerous accidents may occur during the course of the operation. In making the corneal section the knife may be caught in the iris, in which case it may be gently withdrawn until disengaged and then pushed forward. If it

cannot be disengaged readily, it may be pushed along, slightly tilting the point of the knife forward, until it again emerges into the anterior chamber, to the opposite corneal margin at the point of counterpuncture. This accident is usually due to a shallow anterior chamber and lack of skill. Always keep the knife-blade in view, in the anterior chamber, between the cornea and the iris. When the iris is punctured or cut, hemorrhage in the chamber is likely to follow. This occludes one's vision, but, as a rule, does no harm, as it is stroked out with the lens or is absorbed soon after the operation is completed. When the iris is cut, an iridectomy will have to be done to get the best visual results.

Prolapse of the iris sometimes occurs when a large portion of this body passes through the corneal wound. In the majority of cases this can easily be replaced by the shell-spoon or replacer. If it cannot be so replaced, it must be grasped with the iris forceps and cut off near the wound.

The lens capsule may also be cut in the passage of the knife through the anterior chamber. This weakens the resistance, and pressure of the lids or too much pressure upon the eyeball with the fixation forceps may cause the lens to be delivered spontaneously as soon as the corneal section is completed. If no vitreous follows this accident, the operation may be completed in the usual way. If vitreous escapes when the lens is extracted, the speculum should be immediately removed

and the eye closed. After a minute's rest the lid may be raised with the finger, and the escaping portion of vitreous cut away with a pair of small sharp curved scissors. The lid should be immediately closed and the dressing applied, but too much pressure over the closed lid must be avoided. The escape of a little vitreous does no special harm, but the loss of a large quantity lessens the support of the retina, and it may become detached from its normal position.

Iritis and cyclitis follow extraction in a small percentage of cases. It is often due to irritation by retained portions of the lens substance, also to constitutional diseases, and severe traumatism during or following the operation. The condition must be met by the use of atropin and the usual treatment for iritis.

Delayed healing of the wound sometimes occurs, even when the wound is free from capsule, lens, or vitreous substance. Spasmodic contraction of the lids, too great pressure of the bandage, and supervening glaucoma must be looked for. If, after these conditions have been corrected, the wound still gaps, the edges may be touched with the silver nitrate stick.

**Dressing.**—A light pad of absorbent gauze should be placed over the eye and retained with strips of adhesive plaster. It is well to place a layer of absorbent cotton between the layers of gauze. Over this a suitable metallic mask may be placed to prevent the eye from injury in the act of rubbing. The mask should be

large enough to rest on the bony structures about the eye and not on the eye itself. It may be sewed into a canvas or leather support, and this fastened over the ears and under the jaw by means of buckled straps.

In the human subject some surgeons let the dressing remain five days before removing it, when the wound will be healed. Others prefer to dress the eye and ex-

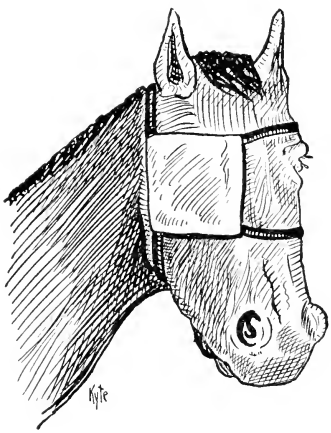

Fig. 32.—Simple eye-protector for horse. Buckles on the ends of the straps are not shown.

amine it every day. There are some objections to both these methods. If, after twenty-four to forty-eight hours, the animal has done itself no injury, and there is no evidence of secretion on the dressing next the eye, it should be disturbed as little as possible. If there be secretion present, a clean dressing should be replaced, after gently washing the closed lids with a warm boric acid solution.

One will have to use much judgment in each case as to his after-treatment, which will depend greatly upon his knowledge of existing conditions, and the result of

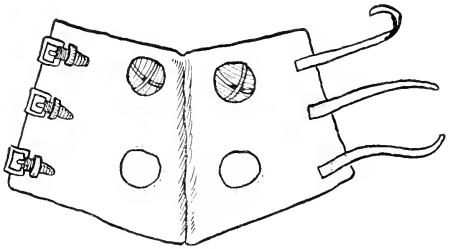

Fig. 33.—Brusasco's eye-protector for the dog.

an operation will depend very largely upon such knowledge and skill.

If the pupil is clear, and there is no evidence of capsular and iritic adhesions in the pupillary area, the vision

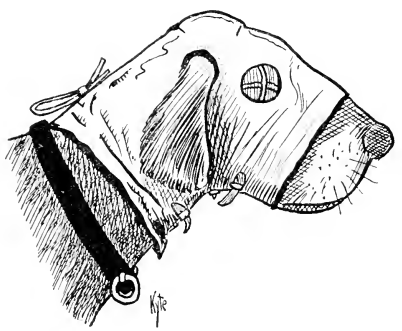

Fig. 34.—Brusasco's eye-protector applied.

will be fair. Of course, we must always take into account the refraction of the lens which has been re-

moved. In man, this can be replaced by a glass lens in front of the eye, but in animals this is altogether out of the question at the present time. However, where the animal was once blind, it can now see enough to travel about, though, if of a highly nervous temperament, it may shy until it becomes accustomed to its changed condition.

## CHAPTER XIV

### RECURRENT OPHTHALMIA

RECURRENT ophthalmia is commonly known as "moon blindness" and periodic ophthalmia. It has no relation to the moon's changes, but, being subject to periodic attacks, it has been known by the latter name.

It seems to be particularly confined to the horse, and the favorite site of inflammation is the uveal tract, though the whole structure of the eye may be involved. An initial attack may apparently get well, but in the course of thirty to ninety days it may recur, and if these recurrences continue the eye may be eventually lost.

The true cause of the disease is not known, though it is supposed to be of bacterial origin. Koch found cocci in the aqueous, which when injected into the normal eye of a horse produced a typic ophthalmia with the loss of the eye. Other investigators have found various organisms, but none has been definitely determined to be the specific cause. The principal predisposing cause is heredity. Law says, "This hereditary susceptibility is so strong and pernicious that intelligent horsemen everywhere refuse to breed from a

mare that has once suffered from recurrent ophthalmia, and at the government studs in France not only is every unsound stallion rejected, but the service of a healthy stallion is refused to any mare which has suffered from disease of the eyes. A consideration for the future of our horses would demand that no stallion shall stand for the public service of mares unless he has been examined and licensed as a sound animal." The months of spring have some influence in producing an attack, as well as pasturing on swampy lands, damp stabling, improper and overfeeding, intestinal irritation, local irritants, and debilitating diseases. These may all be exciting causes, yet there must be some specific bacterium which is the primary factor.

*Symptoms.*—The disease first shows itself by local irritation due to a low grade of uveitis, with a faint whitish flocculent deposit in the anterior chamber. There are later manifestations of iritis and cyclitis with photophobia. The pupil is sluggish in its action, even when mydriatics are employed. Exudates are thrown off from the iris and adjacent body, and are deposited in the dependent portion of the anterior chamber. In many cases a lymph deposit is diffused through the aqueous, imparting to it a milky appearance and entirely closing from view the pupillary area. The cornea becomes hazy from the presence of this material on its posterior surface and from cellular infiltration. If the inflammation is not too severe, it ceases in from twelve

to fifteen days, and the eye resumes its normal appearance. During this period of quiescence the lesions due to the initial attack may be noticeable. In from one to three months a recurrence will take place, with much greater severity than the former attack. All the symptoms of a severe iridocyclitis prevail, together with an increase of the intra-ocular tension (glaucoma) and the formation of an opaque lens (cataract). The sclera about the ciliary border takes on a different aspect, being dark or bluish-black in color. The vitreous becomes opaque, and after two or more attacks symptoms of degeneration appear, and the globe becomes shrunken and is apparently retracted.

The disease seems to be most formidable, in that it is not satisfied with one eye, but in time attacks the fellow eye and destroys that also in like manner. Whether this is due to sympathetic involvement, as is often seen in man, which is reasonable to assume, or whether it is due to the original cause, is a question. The fellow eye is sometimes attacked and destroyed, even while vision remains in the eye which was first affected.

*Treatment* seems to be of little value in most cases. Local conditions should be met by proper therapeutic measures, together with the observance of hygienic conditions and proper feeding. The animal should be isolated from other animals, and should not be used for breeding purposes.

## CHAPTER XV

### GLAUCOMA

GLAUCOMA is characterized by an increase of the intra-ocular tension—that is, the eyeball is harder than normal, and its hardness may continue to increase until there is absolute resistance to pressure by the finger-tips. Make a practice of taking the tension in all diseases of the eye as a part of the routine examination, and acquaint yourselves with the normal tension of the eyes of different animals. This is done by pressing the eyeballs, above the cornea, over the closed lids, with the tips of the index-fingers; first gently pressing with one finger, and then with the other, as in testing for fluctuation. There is an instrument devised for this purpose, called a tenometer, but with practice and experience the finger-tips are reliable.

The cause of increased tension is due to a damming up or failure of the lymphatics to perform their function, the principal one being Schlemm's canal, located in the sclera, just anterior and external to the spaces of Fontana or the filtration angle of the anterior chamber. This angle is adjacent to the anterior portion of the ciliary body and the root of the iris. For this reason

atropin, or any other agent which causes a thickening of the iris at this point, should not be used in cases of glaucoma or in a subject predisposed to an attack, as in the first instance it will only increase the trouble and probably ruin the eye, and in the second instance it will induce an attack.

The simple type of glaucoma comes on very gradually, is not accompanied with inflammation, and there is little or no pain. It occurs in both eyes. The tension may vary at different times, and often during the first stage it is not recognized. As the condition advances the pupils become somewhat dilated and sluggish, the cornea is clear or slightly hazy. The visual field is much contracted, and the acuity of vision is greatly reduced. The intra-ocular pressure is continuous and increases, and, because of this, the weaker portions of the head of the optic nerve give way and are pushed backward, and by an ophthalmoscopic examination a deep cupping of this portion of the nerve can be seen. The retinal blood-vessels seem to be lost at the margin of the disk, caused by the cupping and dipping down of the vessels at this point. This cupping of the disk varies in degree, according to the duration of the tension. If the condition is not checked, vision will ultimately be destroyed. This simple type of glaucoma often becomes inflammatory in character.

The *inflammatory* type of glaucoma is usually accompanied with a great deal of pain, which may be

confined to the eyeball or the region about the eye. The globe is reddened and the large episcleral vessels are engorged. The cornea is hazy in appearance, and the pupil is enlarged and sluggish. The anterior chamber is shallow and the iris is pushed forward. The prognosis is extremely bad.

This type is often secondary to diseases of the eye, such as iritis with adhesions, hemorrhages in the retina and chorioid, and to traumatism. It is also one of the conditions which accompanies recurrent ophthalmia in the horse.

*Treatment.*—The object in the treatment of glaucoma is to relieve the pressure from Schlemm's canal and re-establish its function. In order to do this with a drug we must use a myotic, or one which causes a contraction of the pupil. Eserin in solution of $\frac{1}{4}$ to $\frac{1}{2}$ per cent., or pilocarpin in solution of 1 per cent., may be dropped into the eyes three times daily. In simple glaucoma this treatment is about all that is necessary, though it will have to be continued for months or perhaps years.

In inflammatory glaucoma the same drugs are used, but if pain exists, as it most always does, it will be necessary to do an iridectomy. To get the best results a broad excision of the iris should be made near its base or root. The tension is often immediately reduced following this operation. A too sudden reduction of the tension may do harm, as the sudden inrush of blood

into the retinal vessels may cause them to give way, and an intra-ocular hemorrhage will be the result. For this reason, before doing an iridectomy, it is better to do a paracentesis, and allow the gradual escape of the aqueous and a gradual lessening of the tension.

# CHAPTER XVI

## INJURIES OF THE GLOBE

INJURIES of the eyeball in general are simple contusions, with rupture, incisions, punctures, and lacerations.

**Contusions** are produced by a blow with some blunt object. Simple contusions without rupture may be apparently trivial or much damage may be done. The results of simple contusions are paralysis of the sphincter pupillæ, causing dilatation, rupture of the suspensory ligament, dislocation of the lens, rupture of the border of the iris, causing a separation and an opening (iridodialysis), hemorrhage in the anterior chamber, subconjunctival hemorrhage, rupture of the chorioid, and hemorrhage in the chorioid and retina. Contusions with rupture of the globe is a frequent occurrence. Usually the rupture takes place about the sclerocorneal margin anteriorly. It may occur at any point, according to the direction of the blow. The posterior portion of the globe may also be ruptured in an irregular manner, and a general rupture and displacement of the internal structures may occur. The following case, in a colored man, is a good illustration: The man was struck with con-

siderable force by a billiard ball in the left eye. He was seen twelve hours after the accident. The lids were badly swollen, the eye closed. Inspection revealed a rupture of one-third of the cornea near the inner margin. The anterior chamber was filled with blood; the cornea was clear. The case was nursed along with cold antiseptic applications until the swelling subsided. The corneal rupture failed to heal readily, still there was no prolapse of the internal structures. After two weeks' treatment, when efforts seemed to be of no avail in saving vision, the eye was enucleated. The globe was found to have been ruptured posteriorly at a point opposite to the anterior rupture, but much more extensive and in a crescentic shape, nearly three-fourths around the globe. This posterior rupture had readily healed; the sclera was firmly united. This goes to show that the remote rupture is often more extensive than that where the blow was received. In this case the lens was dislocated and the iris torn. About the anterior rupture the cornea was partly opaque or white in appearance. Had the globe been allowed to remain in the orbit it would have been of no value, as its function was destroyed. The globe would have shriveled (phthisis bulbi), and there would probably have been subsequent attacks of inflammation.

**Punctures** of the globe are caused by pointed, sharp, or dull objects, and the result depends upon the location, depth, and the condition of the object—that is, whether

it is clean or dirty. Even if an object is apparently clean, it may carry bacteria with it into the eye and produce terrific reaction. Punctures through the cornea produce a loss of the aqueous and often a prolapse of the iris into the wound, which may become adherent (anterior synechiæ) and interfere with the normal pupillary reaction, or the iris is drawn to one side, producing an irregular pupil. Punctures still deeper cause hemorrhage in the anterior chamber by ruptures of the iris vessels. Besides these, the lens becomes cataractous through rupture of its capsule. The lens often swells, and all the symptoms of glaucoma accompany the accident.

A puncture of the ciliary body by a septic object should always be regarded with apprehension. Prolapse of the internal structures of the globe will depend upon the size of the puncture and the resistance of the external coats. Small punctures of the sclera posterior to the ciliary region are usually unimportant from a surgical point of view, though they often produce hemorrhage within the eyeball and a localized scotoma.

The results of an incision are very much the same as those of a puncture, though there is more probability of a better and more rapid union of the wound by suturing the same.

Lacerations are probably the most severe type of injuries to the globe. The result of a laceration depends upon the extent and the part injured.

Injuries are nearly always confined to the anterior

portion of the globe. A laceration heals much less readily than an incision, and is more liable to infection because of the ragged edges of the wound. Practically the same conditions of prolapse, dislocation of the internal structures, etc., take place in extensive lacerations as in punctures and incisions.

Fig. 35.—Injury of the globe, two months' standing. The contents of the globe prolapsed. Enucleation was done and an artificial eye applied in due season. (Dr. Danner's case.)

**Complications.**—In severe injuries of the globe the neighboring structures may be involved. The lids may be badly bruised, swollen, and ecchymosed; or they may be punctured, incised, or lacerated. The bones of the orbit may be fractured and displaced. The optic nerve may be ruptured, or atrophy follows because of

compression. Cellulitis of the orbital tissues may follow from infection.

**Treatment of Injuries of the Globe.**—The main object in treatment is to save the function of the eye. If vision cannot be saved, our next object is to preserve the globe. In cases where much damage has been done, the vision destroyed, and the eye is unsightly, the most philosophic method would be to enucleate the globe and replace it with an artificial eye; but, for reasons unknown to the profession, an eyeball is often preserved when it is of no earthly use, and often when its ugliness is most conspicuous to friends and passers by.

Always remember the general principles of cleanliness and asepsis in the treatment of all these cases. Wounds should be cleansed of all foreign substances, for the danger of infection is often greater than that of the injury itself.

**Simple abrasions of the cornea,** from blows of twigs or other objects, should be treated with applications of mild antiseptic washes, and an aseptic pad and bandage applied for protection. These superficial abrasions heal rapidly, and the epithelium is soon re-established if the wound is not infected. If the wound becomes infected, infiltration and ulceration of the cornea may follow, when the treatment would be the same as given under Ulceration of the Cornea.

**Perforating wounds of the cornea,** in which the aqueous escapes and the iris is caught in the wound,

require special treatment. After thoroughly cleansing the wound, the iris, if not wounded itself, may be replaced, and, if it is centrally located, a mydriatic should be employed to draw it away from the opening and prevent adhesions. If the wound is near the corneal margin a myotic may be used for the same purpose. If the wound is extensive, and involves the iris with a protrusion of this tissue through the wound, the protruding portion may be excised and a mydriatic or myotic employed, according to the location of the injury. By watching the condition of the iris, and keeping the wound absolutely clean and protected with an antiseptic dressing, nature will produce wonderful results oftentimes in these cases. It is not advisable to stitch a corneal wound.

If inflammation arises by reason of infection, more rigid antiseptic measures must be employed. After thoroughly cleansing the eye of all secretion the insufflation of finely powdered iodoform, boric acid, or equal parts of these may be used, or an ointment of iodoform, with lanolin as a base, is of great value. Should inflammatory reaction of the iris take place the general treatment of iritis must be employed.

Wounds of the conjunctiva and sclera may be brought together with fine sutures. It is preferable to use a silk suture with a needle on both ends, and these passed through the tissue from within outward, the sclera and conjunctiva stitched separately. The ruptured parts

should be brought together evenly, and strict caution should be observed that none of the internal structures be caught in the inclosed wound. In all hopeless cases, more particularly when there is danger of sympathetic inflammation of the other eye arising, the globe should be enucleated.

**Injuries of the Globe, with Foreign Bodies Remaining in the Eye.**—These are always to be looked upon with considerable apprehension. Such bodies may be small or large, sharp or blunt. A small sharp-pointed body may enter the eye and its place of entrance be hardly noticeable. Again, the body may be large enough to lacerate the globe. If the smaller body carries bacteria with it, it may do as much or more damage eventually than the larger body. These foreign bodies are composed of various substances, such as stone, glass, wood, lead, copper, iron, and steel. The wound is much like that of a puncture plus the presence of the foreign body. There is great danger of infection and irritation of the tissues in contact with the foreign body.

It is always advisable to remove a foreign body if it can be located and readily reached. If the body is in the anterior chamber, it may be withdrawn through its source of entrance with a small forceps. If it has passed into the vitreous, it may be necessary to make an incision in the sclera and remove it through that opening.

When the media are clear, the body may be seen with the ophthalmoscope. If it is a substance which will react

to magnetic attraction, the electromagnet is the instrument to use. It is made in two forms—the large or giant magnet, which has a lifting power of 400 pounds or more, and the hand magnet, which is sufficient in most cases.

In making the scleral incision the eye should be drawn in the opposite direction, by an assistant, with a strong fixation forceps. Plunge the Graefe knife into the eye with the edge of the blade backward, and enlarge the opening in the act of withdrawing the knife. The incision should be made far enough back to prevent wounding the lens or ciliary body, and in a position as near the foreign body as possible. The magnet point is now introduced into the wound and the current turned on. The body will usually come in contact with the point, when it can be withdrawn. Authors generally recommend making the scleral incision at a point between the insertion of the muscles, but the writer has made the incision through the belly of the internal rectus muscle in one case, and was successful in removing steel from the vitreous without the loss of a particle of vitreous or injury to the ciliary body or lens. Such an incision must be made parallel to the muscle-fibers, which close and protect the scleral wound.

When the body is embedded in the chorioid it may become encysted, and, if sterile, may do no particular harm, though it may be dislodged, drop into the vitreous, and cause irritation and inflammation. If lodged in the

lens, it may also do no harm for a time, except to produce a traumatic cataract, though the lens may swell and glaucomatous symptoms follow; or the lens, in young subjects, may become gradually absorbed, and the body will drop down, irritate the ciliary body, and produce cyclitis, iritis, chorioiditis, etc.

**Enucleation of the Globe.**—As before stated, it is better, in all hopeless cases, to enucleate the globe. This is much more difficult to do in the quadruped than in man, because of the large retractor muscle. The steps of the operation are as follows:

General anesthesia should be used in all cases, as we are not justified in causing the dumb beast to suffer more pain than is necessary. Wash the eye and the surrounding parts with soap and water, followed by an antiseptic solution. Apply the speculum, or have an assistant hold the lids open with retractors. Make an incision through the conjunctiva, around the corneal margin, preserving as much of the tissue as possible. Undermine the conjunctiva as far back as the insertion of the muscles, keeping as close to the sclera as possible. Pick up the muscles individually with the tenotomy hook, and cut them, with the small curved scissors, near their tendinous insertion. Cut away, gradually, the insertion of the retractor muscle, then pass in the strong curved scissors, grasp the optic nerve, and divide it with one snip if possible. In doing this the handle of the scissors must be raised, not lowered, as

there is danger of cutting the sclera itself. The globe can then be gradually pried out and any adhesions cut away.

When the globe has been removed, the hemorrhage can easily be stopped by placing a dry aseptic gauze

Fig. 36.—Enucleation of the eye. This is an old method and is used today by many operators. It seems, however, that the use of ether, the relief of pain, and more careful dissection would be a more scientific and humane procedure.

within the capsule. When hemorrhage has ceased, withdraw the gauze and close the eye, when the tissues will contract and come together naturally. Some surgeons close the wound with a puckering suture through the conjunctiva, but this is hardly necessary

in the animal. It is well to place some absorbent powder on the fissure and apply a compress bandage.

Healing takes place readily, and a good stump is soon formed for an artificial eye. These, for the animal, are usually made of hard rubber, as they are less easily broken, and the coloring conforms more to animals' eyes than those made of glass.

An artificial eye should not be placed until the wound is healed and there are no inflammatory symptoms present.

**Prolapse of the Eyeball.**—It is understood by some of the laity that "the eyeball can be taken out, scraped, and put back again into the orbit." Any one with a knowledge of the eyeball and its muscular attachments can readily see the folly of this assumption. In the dog, however, the eyeball is not held very securely in the orbit, because the anterior bony arch is wanting, and the eyeball is supported only by the ligamentous attachments and the lids. For this reason, the eyeball of the dog is often prolapsed or dislocated forward by traumatism. It is said also to prolapse by reason of inflammatory processes within the globe, but this cause must be exceedingly rare. It is more probable that progressive tumors within the orbit might be the cause.

Prolapse of the eyeball presents a very peculiar and ugly appearance. The writer once saw an English bulldog whose eyeball was dislocated outward and downward by fighting with another dog. It was held in this

condition by contraction of the orbicularis palpebrarum. This was a simple dislocation, without rupture of the conjunctiva or any of the muscles of the globe.

*Treatment.*—If the eye cannot be readily put back into place, it will be necessary to produce general anesthesia in order to allay the sensitiveness of the cornea and relax the contracted muscles. Then, with gentle pressure with the thumbs and fingers over the outer and inner portions of the globe (avoiding pressure on the cornea), reduce it to its normal position. If you fail in doing this, make traction of the upper lid outward with an elevator. If you still fail to reduce it, the outer tendon of the orbicularis may be divided, when it can readily be reduced. This must be brought together again with sutures in order to support the globe, or it may be again dislocated spontaneously. If too long a time elapses before the reduction of the globe, the cornea becomes dry and hazy by reason of exposure. It soon resumes its normal transparency, but if it does not it must be treated as a superficial keratitis.

## CHAPTER XVII

### FRACTURE OF THE ORBIT

FRACTURE of the orbit takes place usually near the orbital ridge of the frontal bone, though any bone of the orbit is subject to fracture by direct injury or concussion.

Horned animals receive such injuries by fighting with other animals, or the injury may be self-inflicted while suffering with colic and other severe pain.

When fracture of the orbital ridge takes place, crepitation may be felt while manipulating the parts, or the fractured part may be entirely displaced and deformity result. Fracture of the inner walls of the orbit may result in blindness (amaurosis) of the eye by pressure upon the optic nerve. Cellulitis and abscess of the orbital tissue may follow fractures caused by penetrating wounds.

**Treatment.**—Cold applications to prevent or reduce swelling and inflammation. Remove all dirt and foreign substances from the wound and apply antiseptic dressings. If an abscess forms, it must be drained externally by opening the wound with an aseptic probe. The wound must be kept open, and this can be done by placing in it a small wick of iodoform gauze, which may be held in place with aseptic absorbent gauze and bandage.

When atrophy of the optic nerve takes place from pressure, very little can be done. If cellulitis and abscess are not controlled by the above measures, it will be necessary not only to enucleate the eyeball, but, in many cases, to cut away all the tissues in the orbit (exenteration), as the pus may burrow through the sclera, causing a panophthalmitis, or it may endanger life by extending to the meninges of the brain.

## CHAPTER XVIII

### PARASITES OF THE EYE

**Parasites of the Eyelids.**—The eyelids are subject to the invasion of various parasites as follows:

*Pediculi* (*Lice*).—These are often seen along the margin of the lids when present on other portions of the body.

The eggs are found embedded or deposited near the lashes, and are often covered with crusts resulting from the secretion caused by their irritation. They produce a marginal blepharitis. The crusts should be softened with the yellow oxid of mercury ointment and removed. A piece of absorbent cotton, dipped in absolute alcohol and gently rubbed over the lids, will catch and remove the lice and their eggs.

The *Filaria palpebralis*, discovered as early as 1429 on the conjunctiva of the horse, is a cylindroid worm, 8 to 15 mm. long, and thin at the extremities.

The presence of this parasite causes an inflammation, varying from a slight to a severe conjunctivitis, with swollen and painful lids.

Law mentions a case in which "the lids were firmly closed, the flow of tears abundant; the cornea was vas-

cular in its outer portion, with a surrounding area of opacity, which was followed with a bluish-white opacity of the whole cornea excepting the inner canthus. Under treatment there was a general improvement, but a month later there was a new attack, and five filaria were discovered under the eyelids. The cornea became opaque and permanent blindness ensued."

In some cases there are no symptoms to indicate the presence of the parasites. The only way to diagnose the trouble is in finding the worms, and in many instances this is not an easy thing to do, as they may be concealed within the conjunctival folds, and are not sufficiently active unless the surfaces are quite moist.

*Filaria Lacrimalis Bovis.*—This resembles the worm last described. The female is from 20 to 24 mm. in length. It is usually found on the conjunctiva at the inner angle.

The symptoms excited by the presence of this parasite resemble those last described—viz., a certain amount of swelling of the lids, partial ptosis and lacrimation, together with inflammation of the conjunctiva and cornea.

The worm can readily be seen in motion on a moist eye if carefully looked for.

The *Demodex folliculorum*, commonly called the "pimple mite," is often found in the miebomian glands of the horse, dog, and sheep. As a rule it does not cause any marked disturbance.

The *Trombidium*, an extremely small silky worm, invades the margin of the lids of the dog. Its more common site is at the outer and inner canthi. The symptoms produced by this are not marked.

The *Trichina* is said to have been found in the muscles of the eyelids, as well as in other muscles of the body. They cause swelling of the lids which is usually painful, conjunctivitis, etc. The general symptoms of trichina are also present.

The *Hemopis sanguisuga*, the horse leech, has been found clinging to the lids and conjunctiva of the horse under favorable conditions.

**Parasites Found Within the Eyeball.**—The *Filaria oculi equina*, also known as the *Filaria papillosa* and the *Filaria pellucida*. This is not infrequently seen in the eye of the horse. It was known as early as the seventeenth century, and has been discovered by various observers in this country and in Europe.

It seems to be more prevalent among animals which are allowed to graze in wet pastures in moderate climates.

It is described as a thread-like worm, from 22 to 35 mm. long, the male being the longer, with spiral tail, and reddish-white in color.

Law describes the symptoms as follows: "Exceptionally the worm causes no inflammation, and it can be seen actively bending and unbending itself in the form of a loop, a figure-of-eight, or a spiral, in the anterior

chamber. Usually there is considerable inflammation, closure of the lids and watering of the eyes, redness of the mucosa, clouding, and even vascularity of the cornea. Still, in a majority of the cases, a portion of the cornea remains sufficiently transparent to allow the movements of the worm to be seen. Sometimes it will temporarily retreat through the pupil and disappear behind the iris. Sometimes only one eye is involved, in other cases both eyes, and in some instances two or even three parasites are found in one eye."

If the worm can readily be seen in the anterior chamber, an incision may be made in the margin with a cataract knife, when the worm may be grasped with a small pair of forceps and withdrawn. Cocain must be used to anesthetize the cornea and strict antisepsis observed. Much care must be observed not to wound the iris or the cornea in this operation.

*The Cysticercus Cellulosa.*—This has been found in various portions of the eye—in the vitreous, the chorioid, retina, the anterior chamber, the muscles of the globe, and beneath the palpebral and bulbar conjunctiva.

It has been found in the eye of man, the horse, the dog, and the pig. When it appears in the outer coats of the eye it is described as a white ovoid body. Within the vitreous "the cysticercus becomes visible as a bluish-white bladder" (Duane). When in the anterior chamber it has the appearance of a white cyst upon the iris.

Within the eyeball it is usually stationary, though it has been seen to make quick, active movements.

Inflammation of the internal structures usually follow its entrance into the eye; detachment of the retina and cataract occur, vision is eventually lost, and the globe becomes atrophied.

Attempts have been made to remove the organism by making an incision in the sclera and grasping it with a small pair of forceps; and, if it is in a position where it can readily be reached, this may be done; but, in the animal, one would assume a great risk in not being able to grasp it, and much damage would be done the globe in making the attempt.

# CHAPTER XIX

## THE PRINCIPLES OF VISION

VISION is dependent upon light. Rays of light from a distance are parallel, while those from near objects are divergent.

*Refraction*[1] means the turning or bending of rays of light as they pass through an object that is denser than the air. A good illustration of this is the apparent bending of a spoon upward when placed in a glass of water, or the displacement of an object when seen through a prism.

The index of refraction is the resistance of the object through which the light passes as compared with air, which is taken as 1.

When parallel rays of light pass through a plate-glass with both surfaces parallel they are not refracted, but emerge as they entered, but when they pass through a glass that is thicker at one edge than the other (a prism), they are deviated, or refracted from the apex toward the base, or the thicker portion of the prism. The *angle of refraction*—that formed by the incident ray with the

[1] Only a primary description of refraction will be considered. For a more complete study of refraction of light, the writer would refer the student to some good work on physics.

refracted ray—depends upon the strength or degree of the prism. Prisms are numbered from $\frac{1}{2}$ degree up.

*Spheric lenses*—those cut from a sphere—are refracting lenses. The convex or plus spheric lenses—of which the crystalline lens of the eye is a type—collect rays of light at a point on the opposite side; while concave or minus spheric lenses diverge rays of light on the opposite side. Rays passing through the optical center of a lens are not refracted.

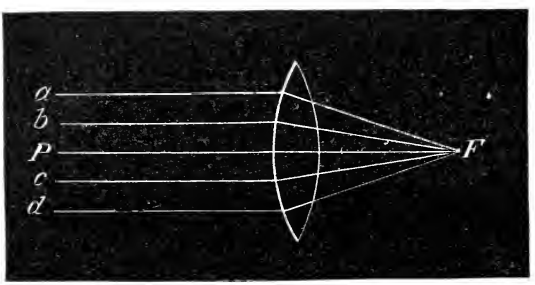


Fig. 37.—Principal focus of a convex lens. The parallel rays *a*, *b*, *c*, *d* are refracted by the lens so as to unite at the point *F* on the axis *P*; the ray *P* undergoes no refraction. *F* is the principal focus. (de Schweinitz, "Diseases of the Eye.")

The point at which parallel rays are collected is the *principal focus* of the lens. The distance of this point from the optical center of the lens depends upon the radii of curvature and its index of refraction. Rays which diverge, back again through the lens, become again parallel.

When rays come from an object nearer than "infinity" —supposed to be about 20 feet—they diverge, and are

collected at a point on the opposite side of the lens, at a greater distance from the optical center of the lens than the principal focus. The nearer the object is to the lens,

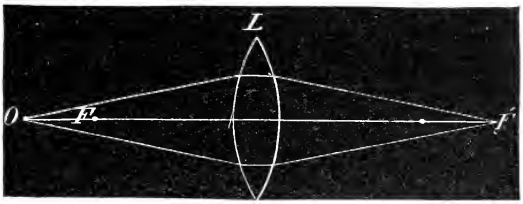


Fig. 38.—Conjugate focus of a convex lens. The two dots in the axis represent the principal foci, one being marked *F*. Rays diverging from *O* converge after refraction to the point *F'*, farther than the principal focus. Rays from *F'* also converge after refraction to *O*. *O* and *F* are conjugate foci. (de Schweinitz, "Diseases of the Eye.")

the greater is the divergence, and the farther is the convergence on the opposite side. These two points—the point of divergence and the point of convergence—are

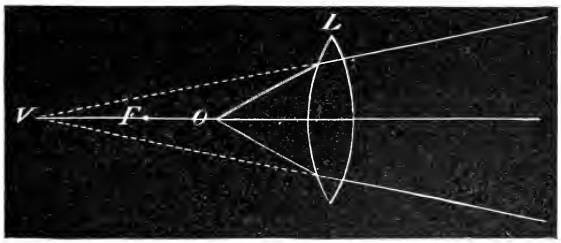


Fig. 39.—Virtual focus of a convex lens. Rays from the point *O*, less than the principal focal distance, diverge after refraction as if they came from the point *V*. *V* is the virtual focus of *O*. (de Schweinitz, "Diseases of the Eye.")

known as the conjugate foci. These points are at an equal distance when the point of divergence is at a distance twice the focal distance of the lens.

The virtual focus of a convex lens is the point at which rays meet in a backward direction on the same side of

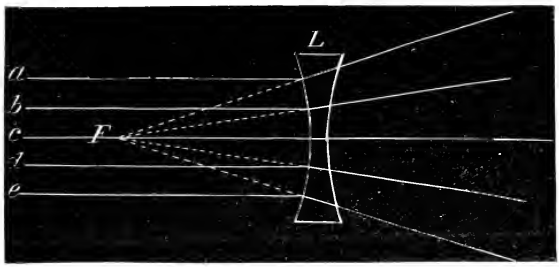


Fig. 40.—Principal focus of a concave lens. Parallel rays *a*, *b*, *d*, *e*, after refraction by the concave lens *L*, are rendered divergent as if they came from the point *F* on the axis *c*. The ray *c* is not refracted. *F*, the principal focus of a concave lens, is virtual. (de Schweinitz, "Diseases of the Eye.")

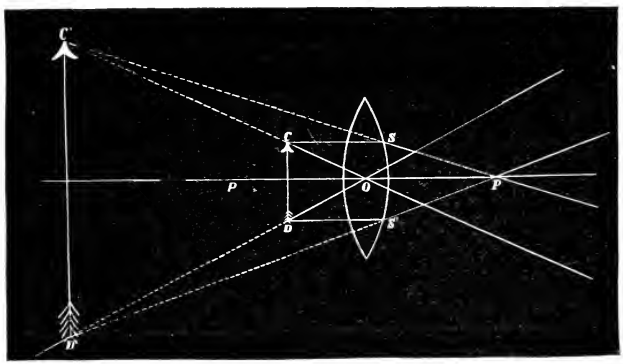


Fig. 41.—Virtual image of a convex lens: *C*, *D* is the object; *C'*, *D'* is the virtual image, erect and magnified. (de Schweinitz, "Diseases of the Eye.")

the lens to which they diverge, when the point of these divergent rays is nearer to the lens than its principal

focus. In this case the rays on the opposite side of the lens, instead of converging, continue in a divergent course.

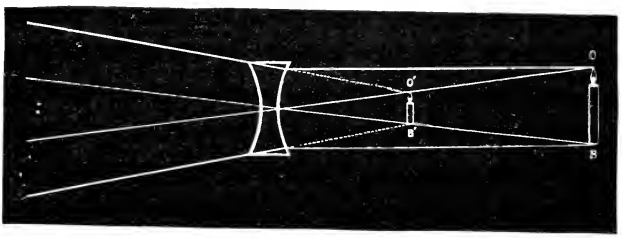

Fig. 42.—Virtual image of a concave lens: $O'$, $B'$ is the virtual image of the candle; $O$, $B$, erect and diminished in size. (de Schweinitz, "Diseases of the Eye.")

The virtual image, seen through a convex lens, is magnified, while that seen through a concave lens is reduced.

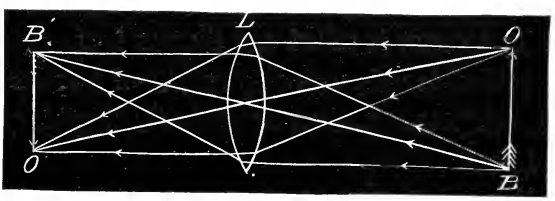


Fig. 43.—Image formed by a convex lens: $O$, $B$ is the object; $O'$, $B'$ is the inverted image. (de Schweinitz, "Diseases of the Eye.")

The image formed by a convex lens is inverted. This is so with the image formed upon the retina. (As an example, look at the image on the ground-glass of a camera.) Following the refraction of this image for-

ward, it again becomes upright. (As an example, place a lantern-slide, inverted, in a "magic lantern," and the picture is projected upright on the screen.)

Lenses used for the correction of refractive errors—spectacle lenses—are the spheric, concave and convex, and cylindric lenses. The spheric lenses are cut from a sphere, that is, the surfaces have an equal radii of curvature. Such lenses are called biconvex or biconcave. Those with a plane surface on one side and a curved surface on the other are called planoconvex and planoconcave spherics. Cylindric lenses are cut from a cylinder, and refract at right angles to the axis of the cylinder. These are also convex and concave.

Convex lenses are called plus (+) and concave lenses are called minus (−).

Lenses are now numbered according to their focal length in metric measurements. A lens whose focal length is 1 meter is called a 1 diopter lens. A lens of 2 meters focal length, 0.50 diopter; one of $\frac{1}{2}$ meter focal length, 2 diopters. A meter equals in the English system 39.37 inches.

A plus one diopter spheric lens is designated thus, +1.00 D. S. A minus one diopter spheric lens is written, −1.00 D. S. In writing for plus or minus cylinders, the same signs are used before the number, but in place of the S. a C. is used, and, following this, the axis of the cylinder is indicated, thus: +1.50 D. C. Ax. 90°; −2.00 D. C. Ax. 180°.

A plus lens is neutralized by placing a minus lens of equal "strength" before it. For example, place a +1.00 D. S. before a −1.00 D. S. and it has the effect of a glass whose sides are parallel.

When the rays of light enter the eye from an object at infinity, that is, from a distance of 20 feet or more, the normal eye should be at rest, and the object will be "focused" or formed sharply upon the macula. The image on the retina is inverted. The rays cross at a point which is, approximately, in man 15 mm. anterior to the retina and 5 mm. posterior to the cornea. This is according to a schematic eye devised by Donders. (These distances would be relative in animals' eyes, according to the size of the eye.) An object 1 meter long vertically, placed at 15 meters distance from the eye, would produce a retinal image in vertical measurements, 1 mm. The *size* of the retinal image is influenced by the variations of the visual angle, and the latter varies according to the size and distance of the object from the eye or the optical center of the lens.

The **acuity of vision** is the ability to see objects of a certain size and at a certain distance distinctly. This depends upon a normal visual apparatus and proper light. Under normal conditions the visual acuity of animals of a kind should be the same. A bird, however, can see a grain or creeping thing at a much greater distance than can a cow or horse. They, therefore, have a greater visual acuity. Man can count the bricks

of a building when near to it, but at a distance he can only discern the outline of the structure. It is the normal visual acuity that we seek to obtain in man when we correct the vision in cases of refractive errors. Fuchs says: "We select for the test not one, but two parallel lines, and then determine the greatest distance from the eye at which they can still be perceived as separate objects. From this can readily be calculated the minimum visual angle, which, for a normal eye, amounts to about 1′." (Snellen's test-types have been constructed upon the basis of this determination, but for whom this work is intended—the veterinarian—it is unnecessary to go further into this particular subject or to discuss the test-types and their value in the correction of the refractive errors in man.)

Eyes that are defective range from nearly the normal visual acuity to mere perception of light. These defects may be due to errors of refraction or diseases of the retina, chorioid, optic nerve, cornea, or lens. A disturbed nutrition of the eyeball may produce a torpor of the retina which causes a reduction in the visual acuity, particularly if the illumination is not perfect. In these cases the vision is greatly reduced, proportionately after dark.

**Accommodation.**—Should the power to accommodate vision be paralyzed, the image of an object within the distance known as infinity—about 20 feet—would be very imperfectly formed upon the retina, because the

focal point would fall relatively behind the retina. To produce acute vision for all near objects it is necessary to accommodate the vision, which is done unconsciously. For example, take a tripod camera, throw the focusing cloth over your head, and focus an object at 100 feet distance on the ground glass; now, without changing the focusing apparatus, view some object at, say, 10 feet distance from the camera, and you will notice the image on the ground glass is blurred. Now rack the lens forward, increasing the distance from the lens to the ground glass, and the real image will appear sharply cut in detail. This is called focusing the object. Accommodation of vision is practically the same thing, except it is done in a different way and by a physiologic organ instead of a physical apparatus. Accommodation is accomplished not by increasing the distance between the lens and the retina, but by increasing the convexity of the crystalline lens sufficiently to cause a clearly defined retinal image. The ciliary muscle is the governor controlling the variations in the convexity of the crystalline lens for all distances within 20 feet. When the ciliary muscle contracts, the zonule of Zinn, which supports the lens to the muscle, relaxes, allowing the lens in its capsule to expand and become more convex by its own elasticity. The nearer the object to the eye the greater must be the accommodation.

In young subjects accommodation is very easily accomplished because the lens is soft and very readily re-

sponds; but in older subjects it loses its elastic qualities and responds less readily to the action of the ciliary muscle, and objects which could formerly be seen near the eye have to be carried much farther away to be seen distinctly. This is noticeable in man at about forty-five years of age, and spheric lenses have to be placed before the eyes to make up the deficiency. The condition is known as presbyopia.

Accommodation is usually determined between two points, known as the near point (punctum proximum) and the far point (punctum remotum). The near point is that point nearest the eye at which a certain object can be seen distinctly. The far point is the greatest distance from the eye at which the same object can be distinctly seen. These points vary with different individuals, and especially so when errors of refraction exist.

The hyperopic eye will necessarily have to accommodate proportionately more than normal, and the myopic eye less so or not at all. This is because, in the first instance, the focus is back of the retina when the accommodation is at rest; and, in the second instance, it is anterior to the retina. In hyperopic eyes the ciliary muscle is overdeveloped, while in myopic eyes it is often atrophied from non-use.

During accommodation the eyes converge proportionately to the distance, and the pupil is diminished in size, reflexly. The pupil is dilated when the muscle of

accommodation is paralyzed. Paralysis of the accommodation is often caused by contusion of the eyeball, influenza, diabetes, and diseases of the central nervous system. Diphtheria is a common cause in man. Belladonna and its alkaloids will produce it temporarily. Spasm of the accommodation often occurs, and when an eye is hyperopic it becomes falsely myopic. It is partly for this reason that a cycloplegic should be used when the eyes are being tested for refractive errors.

The retina is the receptive coat of the eye (as the dry plate receives the image in the camera), and the direct image received by the retina falls upon the "macula lutea," which is in the direct visual axis. The retina is composed of nerve-elements intimately associated with the optic nerve-fibers. These nerve-elements, the so-called rods and cones—particularly the latter, of which the macula is principally composed—are exceedingly sensitive to the vibration of light rays. The image is produced by the vibration of these light rays refracted or focused upon the macula, which is transmitted to the optic nerve-fibers, thence to the center of vision in the occipital lobes of the brain. If the image falls upon the same center of each eye, two images are naturally produced, which become one in the visual center, just as two pictures are fused into one while looking through the spheroprisms of a stereoscope. Double vision (diplopia) is experienced when one or more of the extrinsic muscles are paralyzed.

**Fields.**—When the eyes are fixed upon some object directly in front of them, objects at the left are noticed by the right half of the retina of each eye, while those at the right are noticed by the left half of the retina of each eye; those above by the lower half, and those below by

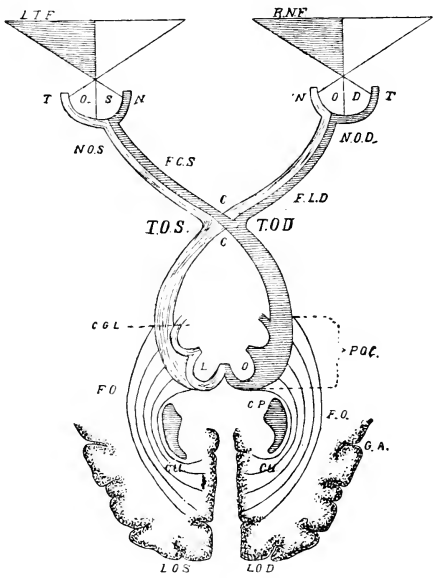


Fig. 44.—Diagram illustrating the visual path and its relation to the visual field, left lateral hemianopsia being shown (Seguin).

the upper half. These are called the fields of vision, and they vary greatly in animals of different kinds. They are influenced by the position of the eyeballs, the prominence of the orbital ridges, the distance between the eyes, and the structure of the face. In man, because of his requirements, the fields are probably greater than in

other animals. The horizontal field is half of a circle, 180 degrees, while the upper and lower fields are somewhat less because of the supra-orbital ridges and the cheek bones. The inner field of each eye, separately, is less because of the nose.

In the lower vertebrates complete decussation of the optic nerves takes place, but in animals of the higher order a partial decussation, or crossing over of the inner portion of the optic nerves, takes place at the chiasm. This causes the image of objects seen from the left field to be conveyed to the right visual center, and those from the right field to the left visual center. It very often happens that an animal cannot see beyond the median line, either to the right or to the left. This is known as homonymous hemianopia (right and left, respectively). Right homonymous hemianopia is due to some defect of the optic nerves, tracts, or visual center supplying the left half of each retina. Left homonymous hemianopia is due to some defect in the optic nerves, tracts, or visual center supplying the right half of each retina. When both outer fields are obliterated it is known as bitemporal hemianopia, and is due to some defect of the inner half of each retina or its optic nerve supply. When the inner fields are obliterated (binasal hemianopia) the outer half of each retina is involved.

When hemianopia occurs in both eyes, as it most always does, it is due to pressure or disease of the optic tracts or visual center. Reaction of the pupil to light,

when the normal half of the retina is shaded, determines the location of the pressure or disease. The pupil fails to react to light when pressure is anterior to the so-called "reflex arc," that is, anterior to the origin of the third nerve.

The fields of vision are greatly contracted in glaucoma and in diseases of the optic nerve and retina, but in a work of this nature it is unnecessary to go into such details.

**Scotoma.**—A portion of the field of an eye may be wiped out by reason of disease or atrophy of that portion of the retina which should receive it. Such a condition is known as a scotoma. For instance, a hemorrhage may occur in the macula which will produce a central scotoma; that is, the object in the direct visual axis cannot be seen, while the other fields are preserved. If the macula is normal, but disease and atrophy occur in some other portion of the retina, the central field will be preserved, but that portion of the field which is received by the diseased portion of the retina will be obliterated.

# CHAPTER XX

## ERRORS OF REFRACTION

THERE is no doubt that some animals have refractive errors as well as man, but, as the requirements of vision are so vastly different from those of man, it will probably be a long time, if ever, when these errors will be corrected by the use of lenses. However, it may be well to give the veterinary student some knowledge of refractive errors at this time.

There are four principal errors—viz.: Hyperopia (farsightedness), myopia (nearsightedness), astigmatism (where one meridian is either hyperopic or myopic), and presbyopia (the natural failing vision of age).

**Hyperopia** is nearly always congenital, and is due to a short eyeball from before backward, so that the focus falls behind the retina. By some effort of the ciliary muscle the focus is brought forward to the retina. In some cases, by gradual development, the eye becomes normal in its anteroposterior measurements, though in many cases hyperopia exists throughout life. A plus (convex) spheric lens is necessary to correct this condition.

**Myopia** is just the opposite of hyperopia; that is, the eyeball is longer from before backward than normal,

and the focus of distant objects falls in front of the retina; consequently, vision is blurred or imperfect, and should the ciliary muscle contract in this case it would only increase the myopia. For all near objects, however, little or no accommodation is required. Myopia is nearly always congenital, though in some cases it is acquired. A minus (concave) spheric lens is used to correct this error.

**Astigmatism** may be simple, compound, or mixed. A simple astigmatism is one in which the eye is hyperopic or myopic in one meridian only. It is known as regular astigmatism when vertical or horizontal and irregular when it deviates from these directions. A compound astigmatism is one in which the eye is hyperopic or myopic combined with an astigmatism of that type. Mixed astigmatism is one which is hyperopic in one meridian and myopic in the opposite meridian.

Astigmatism is due to an irregularity in the curvature or refraction of the cornea, the lens, or both. It may be congenital, but is more often acquired. It often follows operations or disease of the cornea. Simple astigmatism is corrected with a plus or minus cylindric lens, as the case may be. Compound astigmatism is corrected with a plus or minus spheric lens, combined with a plus or minus cylindric lens, as the case may be compound hyperopic or compound myopic. Mixed astigmatism is corrected with a plus spheric and minus cylinder or a minus spheric and a plus cylinder.

**Presbyopia** is a gradual failure of the accommodation for near work. Man becomes presbyopic between forty and fifty years of age. It is due to a gradual hardening of the lens, which fails to respond to the action of the ciliary muscle. This error is corrected by placing before the eye a plus spheric lens.

**Emmetropia.**—An emmetropic eye is one that is normal as far as any refractive error is concerned. The focus of all distant objects fall upon the retina without any effort of the ciliary muscle.

Major-General F. Smith has examined 100 horses' eyes, and found that only 1 per cent. were emmetropic, 3 per cent. were hyperopic, 6 per cent. had mixed astigmatism, and 90 per cent. were myopic.

It is no doubt due to this fact that so many horses shy, as distant objects are not clear until they come suddenly upon them. Dogs and cats were formerly thought to be hyperopic, but recent investigators have found them to be myopic. A large number of wild animals' eyes have been examined and have been found to be hyperopic.

**Method Used to Determine the Refractive Error.**—For diagnostic purposes retinoscopy may be used. The retinoscope is a small, circular, plane mirror with a small hole in the center. A light is placed near the right side of the head, shading the eyes, and a reflection of this light is thrown, at one meter's distance, into the pupil through the refractive media to the retina. The examiner looks through the central opening, and moves the

mirror vertically and horizontally. If the reflection cast upon the retina moves in the same direction as the movement of the mirror, the animal is hyperopic. If the reflection moves in the opposite direction from that of the mirror, the animal is myopic. If the reflection moves with in one meridian and against in the other, mixed astigmatism is present. If it moves with in one meridian and not at all in the opposite meridian, astigmatism is present. If it moves against in one meridian and not at all in the opposite meridian, astigmatism is also present. In man, the correction is made by placing lenses, either plus or minus, before the eye until one is found that will neutralize the movement of the reflection. When the movement is with, plus lenses are used; and when it is against, minus lenses are used. Compound errors are determined when the movement of the same character is greater in one meridian than in the opposite meridian.

In order to get a perfect correction one must control the action of the ciliary muscle by the use of a cycloplegic. Atropin in 1 per cent. solution or homatropin in 2 per cent. solution may be used. The former may be used three times a day for a few days before examination, while the latter has its maximum effect in about an hour's time. It will be necessary to drop this into the eye every ten minutes for an hour at least. The effect of this gradually wears away, so that the animal can accommodate its vision in twenty-four to forty-eight

hours; while, if atropin is used, the effect will last several days.

To do good work requires a great deal of time, experience, and patience. In man, the subjective method of examination usually follows retinoscopy, as the patient will not always accept his full correction. By the subjective method is meant placing the patient at a distance of 20 feet from the Snellen test-types, and requiring him to read the normal line for that distance, either with the exact correction by the retinoscope test or by a modification of that correction.

Of course, it is unnecessary to state that, with the light near the head of the animal, it will be necessary to have the animal in a darkened room. With much experience one can become quite proficient with the use of the retinoscope.

# CHAPTER XXI

## MEDICINES USED IN OPHTHALMIC THERAPEUTICS

THERE is a great variety of medicines used in the treatment of diseases of the eye, but it is better to become familiar with the action of a few remedies and to know when to use them.

*Antiseptic Washes:*

Normal salt solution is a $\frac{1}{4}$ of 1 per cent. solution of common salt. This makes an excellent cleansing agent in mild cases, and is safe to use.

Boric acid in saturated solution. A feebly antiseptic and safe wash to use.

Corrosive sublimate in from 1 : 5000 to 1 : 2000 solutions. This is more antiseptic, but also more apt to be followed by reaction when strong solutions are used.

Nitrate of silver in 2 per cent. solution. It is better to apply this with a swab of cotton or a camel's hair brush. It is converted into chlorid of silver when it comes in contact with the tears, and should be immediately washed off with sterile water.

Argyrol, one of the albumose of silver salts, used in solutions of from 10 to 50 per cent. The strong solutions should be used only in extreme cases of purulent inflammation. Each manufacturer has a name for his special preparation—protargol, argentamin, argonin, etc.—which contain different amounts of silver.

*Astringents:*

Sulphate of zinc in $\frac{1}{4}$ to $\frac{1}{2}$ of 1 per cent. solution.

Sulphate of copper.

Alum. The two last are usually used in the crystal form, rubbed on the everted conjunctiva, and immediately washed off.

Tannate of glycerin, U. S. P.

*Local Anesthetics:*

Cocain hydrochlorid in 2 to 10 per cent. solutions.

Holocain, 1 per cent. solution.

The first also dilates the pupil. The last is feebly antiseptic and does not dilate the pupil.

*Caustics:*

Silver nitrate stick is used to touch ulcerated portions of the lid. It is not used on the globe except to stimulate the edges of an open wound.

Tincture of iodin should never be dropped into the eye, but it is valuable to apply to sloughing ulcers of the cornea or lids, from the point of a pencil of cotton.

Carbolic acid is used in cases in which the tincture of iodin is indicated, and in the same way.

The actual cautery. This may be used in the form of an electric cautery, or a fine platinum wire may be heated in an alcohol flame. It is used in cases of sloughing ulcer of the cornea and in one about to perforate. Great care must be exercised in its use.

*Agents Affecting the Size of the Pupil:*

*Mydriatics* dilate the pupil.

Atropin sulphate, 1 per cent. solution.

Homatropin hydrobromid, 2 per cent. solution.

Hyoscyamin hydrobromid, 1 per cent. solution.

Duboisin sulphate, 1 per cent. solution.

Scopolamin, $\frac{1}{2}$ to 1 per cent. solution.

The first two are the more reliable. They paralyze the accommodation (cycloplegia) as well as dilate the pupil (mydriasis). The first has a more lasting effect, and should be used in cases of iritis, injuries, and ulcers of the cornea. The second is used more for temporary effect for the examination of the fundus, etc.

*Myotics* contract the pupil.

Pilocarpin hydrochlorid, 1 to 2 per cent.

Eserin sulphate, $\frac{1}{4}$ to 1 per cent. solution.

*Lymphagogues:*

Dionin, 5 to 10 per cent. solutions.

Redness and edema of the conjunctiva often follow the initial use of dionin, which soon subsides. In severe cases of iritis and glaucoma the powder is often used in place of the solution.

*Hemostatics:*

The extracts of the suprarenal gland of the sheep. There are numerous preparations of this in solution, such as adrenalin chlorid, adrin, etc. They are used in operations to lessen hemorrhage. In operations on the lids they should be injected hypodermically.

*Ointments:*

Yellow oxid of mercury, 1 to 2 per cent.
Red iodid of mercury, $\frac{1}{5}$ of 1 per cent.
Iodoform, 10 to 20 per cent.
Aristol, 10 to 20 per cent.
Oxid of zinc, U. S. P.
Ichthyol, 5 to 20 per cent.

The first four are used as indicated, in keratitis and ulcer of the cornea. The two last are used in diseases of the skin about the lids. Equal parts of vaselin and lanolin are used as a base.

*Powders:*

Boric acid.
Finely powdered iodoform.
Calomel.

The first two are often mixed in equal parts and used as a dusting-powder following operations on the lids. They are of great value in purulent ulcers of the cornea.

*Combinations:*

When two or more of these medicines are indicated, they may be mixed, if not incompatible; for instance, atropin or pilocarpin may be mixed with an ointment or with a collyrium, etc. It is better to treat each case according to its requirements and not have too many "set" formulæ.

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