THE EYE
IN HEALTH AND DISEASE

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IN HEALTH AND DISEASE:

BEING

A SERIES OF ARTICLES

ON THE

ANATOMY AND PHYSIOLOGY OF THE HUMAN EYE, AND ITS SURGICAL AND MEDICAL TREATMENT.

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"A blind man is a poor man,
And blind a poor man is;
For the former seeth no man,
And the latter no man sees."

BOSTON:
ALEXANDER MOORE.
1871.

Stereotyped by John C. Regan & Co., 65 Congress Street, Boston.

To the Publishers:

Gentlemen, — In reply to the notice I have received that you are to publish in book form the series of Articles on the Eye and its Diseases contributed by me to your Journal, I would say that I have re-read them and made several additions.

I think they will present many new and interesting points to the medical profession, whilst, at the same time, they will serve to accomplish that for which they were written, namely: the instruction of the laity in reference to the care of the most wonderful and delicate organ of the body.

Respectfully your obedient servant,

B. JOY JEFFRIES.

15 Chestnut St., Boston.

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THE EYE

IN HEALTH AND DISEASE.

ANATOMY OF THE EYE.

A MUCH greater knowledge of the eye and its diseases has been the past few years diffused among medical men, than ever before. That the public at large may keep their proper pace with this, is the object of these articles. Our sight, like our hearing, is used with so little consciousness, that we do not realize its importance and value till it is impaired or lost. With regard to the eyes, the old proverb especially holds good, that an ounce of preventive is worth a pound of cure. We will, therefore, try and point out what preventives every one can employ, and what cures every one can avail themselves of. To do this, however, you must learn a little anatomy and a little physiology.

Sit down by the side of a friend, and look attentively at his face, while we explain what you see. Suspended in the bony cavities either side of the nose are the eyeballs, moving freely around their centre of motion. Make a sudden movement of your finger towards them, and down close the lids for protection. One circular muscle around the lids does this, and another raises the upper lid to disclose the globe again to our view. For further protection from dust, dirt, and insects, are the lashes fringing the edges of the lids. Unlucky is the person with whom these do not grow naturally, but turn in and rub on the eyeball, and still more unlucky will they finally be if they continue to pluck out the offending hairs, instead of submitting to the slight surgical operation which eradicates them permanently, or replaces them in proper position.

Covering the inner sides of the lids and the front of the eyeball, is a sack-like, delicate, and very vascular membrane, which the anatomists call the conjunctiva. Lay your finger on the cheek, and draw the lower lid gently down while the person looks as much upwards as possible, and we shall see about the whole extent of the lower portion of the conjunctiva, and thus if any foreign substance is there it will be readily detected, and easily wiped away with a folded soft rag or handkerchief. Both lids have a piece of cartilage in them to stiffen them, like pasteboard, and keep them fitting close to the eyeball. The upper portion of this conjunctival sack can only be seen by turning over the upper lid. The way to do this is to let the person look down with the eyes closed. Taking hold of the lashes with one hand, and applying a pencil, or some small, round, smooth object, over the lid above the globe, we lift the lashes out and up, warning the person to still keep looking down. The lid will suddenly turn over with a little spring from the bending of the cartilage. In this way nearly the whole of the conjunctival sack will be exposed, and any foreign body wiped away as above described. But suppose no friend or oculist is by us to do this. The next best thing is to take hold of the lashes of the upper lid, and draw it forwards and downwards over the lower one, blowing the nose violently with the other hand at the same time.

Stowed away behind the eyeball, just under the outer and upper edge of the bony orbit, is a gland which secretes the tears, from which they flow over the globe, and keep it washed, the act of winking rubbing it clear of secretion. The eye would not be dry if this gland was removed, for the conjunctiva secretes a certain amount of tears, only the person could not then cry. What becomes of the tears? A little row of glands are situated in the edges of the lids, which secrete a sort of oil and wax, and these keep the lashes soft, and form a wall to prevent the tears flowing over. Thus the fluid runs along to the inner angle, where the lids do not meet closely, but have a round space between them. Now draw the upper or lower lid a little away from the globe, and look sharply at a little prominence near the inner angle of the lids, and you will notice a minute opening, which is the entrance to the delicate tubes leading into a sack close to the nose, and out of this opens a tube through which all the tears finally reach the nose. If any of these tubes or passages are closed, the tears must, of course, run over on to the cheek, causing a "watery eye." The longer this lasts, the longer will the best skill of the oculist be called upon to remedy it, and the longer will the patient require to exercise both patience and perseverance. Modern surgery has, however, fortunately done much to abbreviate this time.

The little glands in the edges of the lids which secrete this wax you may see by drawing down the lower lid. They look like little yellow streaks. Both these and the glands which secrete the oil and keep the lashes soft, are liable to inflame, especially after measles in children. The lids are then red, and sore, and swollen. Without seeking advice it is not well to apply to them anything more than sweet oil, or perfectly fresh butter without salt. If the complaint lasts any length of time the lashes are liable to be lost, or to grow wrong, which may produce no end of trouble, and even destroy the sight of the eye. The surgeon's best skill is then required for the patient.

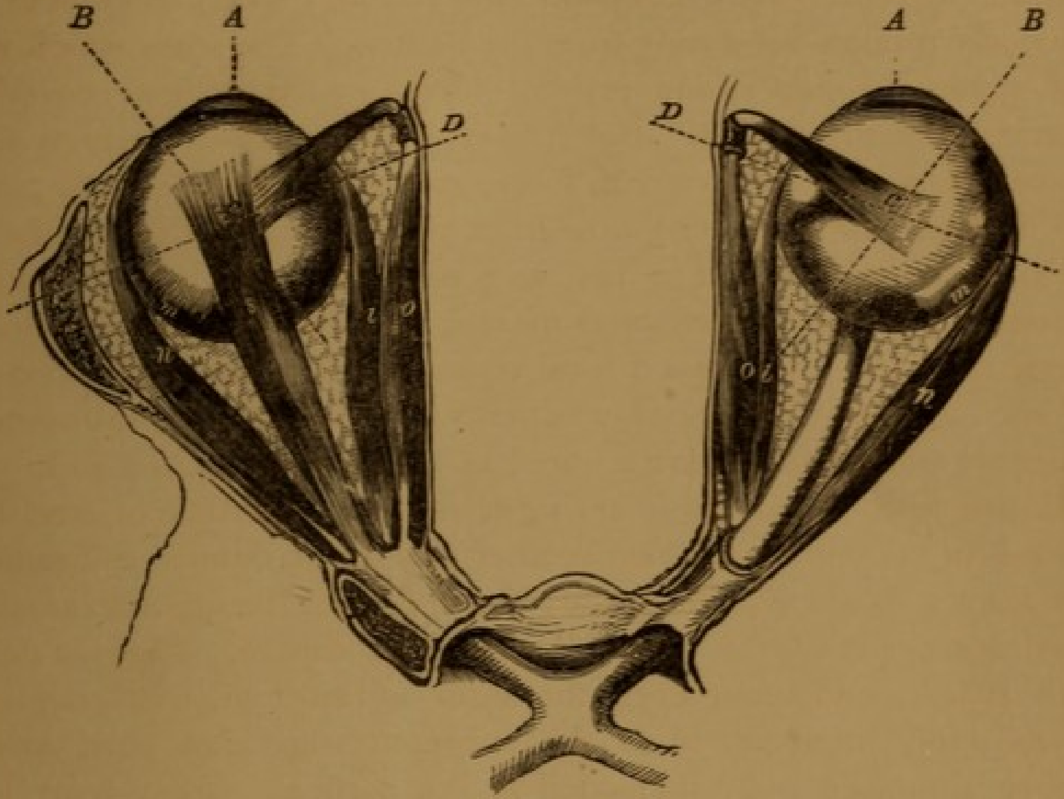
You have now learned something of the natural protections of the eyeball; look, therefore, at *it*, while we explain what you see. With the lids wide open we can see about one-half of the globe, which, as you notice, looks like a white marble with a watch-glass set in the front. The "white of the eye" is the strong, fibrous, enveloping coat which gives the eyeball its shape and protects its contents. The anterior sixth of this coat is perfectly transparent, and projects in a more convex form. It is called the *cornea*, and was formerly thought to be set in the other portion as your watch-glasses are set in the cases. The microscope, however, has shown us a still more beautiful arrangement, namely, that the same fibre which, as a part of the *sclerotic* or white coat, is white and glistening, becomes perfectly transparent in the cornea. The idea that the clear part of the eye was literally a portion of the white of the eye, seemed so impossible, that the above notion of the watch-glass was naturally suggested, till the microscope showed, as is often the case, that truth is stranger than fiction. The cornea is much thicker and tougher than you would imagine. It measures one-twenty-fifth of an inch in thickness, being rather more than the sclerotic. In the living animal it is one of the most transparent objects in nature.

Now you have learned how safely to remove any foreign substance which is in the conjunctival sack, above or below. This membrane called the conjunctiva covers all the eyeball we can see, up to the clear part of the eye, where it stops, and only a most delicate layer runs over the cornea in order that it may remain perfectly transparent. Any foreign substance does not long remain on the conjunctiva covering the globe, but is soon rubbed off on to the lids, and will there be found. You see the necessity of the cornea being clear, to let in the light; therefore any foreign substance *on* or *in* it, is of much more importance to sight, for when it is rough or opaque, seeing is like putting ground glass in our windows and then trying to look out of doors. Substances which blow into the eye, and adhere to the cornea, do not generally penetrate its tissue, and are, therefore, pretty readily removed. No hard substance should be used to do this with, as considerable damage may be done to the eye, and great pain caused.

Take a strip of paper not stiffer than ordinary writing-paper, about a quarter of an inch wide, and roll it up as if you were going to make a candle-lighter. Look at the lower end, and you see it comes to a point. With this point now you may safely attempt to remove any foreign substance from the cornea. The tears which will flow soften the paper, and prevent injury to the delicate covering membrane of the cornea. But it is very different with foreign substances flying into the eye with force, such as pieces of metal, particles of emery or stone, or thorns from plants, etc. These penetrate the cornea, and hold in as fast as a nail in a pine board. In the various factories and workshops there is generally a "*boss*," or some one of the hands, who has a local reputation for successfully removing such articles. If it simply adheres or just sticks into the cornea, a magnet will often remove a piece of *iron* when touched to it. A workman with a jack-knife trying to remove a particle of steel imbedded in the cornea, is like another trying to remove a headless tack from a board with a spade; the difference being that another board is more readily obtained than another cornea. Many a day's work is lost, and often even the sight of an eye, from neglecting to apply immediately to the surgeon, who alone can safely remove a foreign body imbedded in the cornea. Every hour lost under such circumstances is future trouble as well as present pain. A single fold of cotton or linen, wet with cold water and laid over the eye, is all that is needed till surgical help can be obtained. Let us here emphatically warn you never to put an "eyestone" in the eye to remove a foreign substance, notwithstanding you may find them for sale in some of our so-called respectable apothecary shops.

Now look through the watch-glass of the eye, and you will see that which gives the eye its color: namely, the *iris* or rainbow. Hold your hand over the person's eyes while he closes them, and then remove it suddenly when he opens them, and you will see the hole through the iris, called the pupil, become suddenly smaller, or contracting. The iris is a vascular and muscular membrane, placed exactly like an optical diaphragm behind the cornea, attached at its circumference, where the sclerotic joins the cornea, and bathed by

Fig. 1. From RUETE.



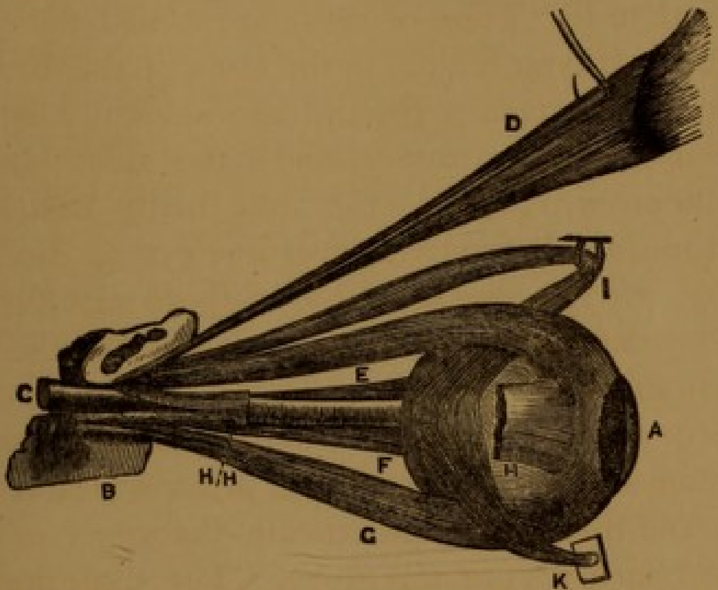
A A, the parallel optic axes. *C C*, the centres of motion of the globes. *B B*, axes of rotation of the oblique muscles. *D D*, axes of rotation of the superior and inferior muscles. *n n*, external straight muscles. *i i*, internal straight muscles. *o o*, superior oblique muscles, running through pulleys at *D D*. *s*, superior straight muscle of one eye. This muscle is removed in the other eye to show the optic nerve. *m m*, attachments of the inferior oblique muscles, which cannot be seen in this view from above. The space between *D D* is the cavity of the nose.

the aqueous humor which, almost like pure water, fills the space between it and the cornea. The circular muscular fibres of the iris around the edge of the pupil, by contracting, reduce the aperture upon the stimulus of light penetrating the eye, and the radiating muscular fibres dilate it again when this stimulus is removed. The pupil is therefore larger in the dark than in the light. The use of the iris is probably entirely physical, to regulate the amount of light, and cut off all rays entering too obliquely. The posterior surface of the iris is covered with a black pigment. The anterior surface reflects light, and is iridescent. When there is but little pigment among its fibres, the posterior thick layer reflects to us a blue or gray, and when a considerable mass of pigment is scattered through the texture, then we have a brown or dark eye. The action of the iris, in reducing or enlarging the pupil, is not under the control of the will. In childhood the pupil is large, and gives expression to the eye; in old age it is small, and the eye "*lacks lustre*," as we say. There is a plant the extract from which dropped into the eye, or applied to the skin in the neighborhood, or taken internally, causes the pupil to enlarge, and thus gives a sparkle to the eye, in consequence of which it received the Italian name of "bella donna," or lovely lady. Simply applied to the eye it is not dangerous, but it is a very powerful poison when taken into the system, and many an accident has happened from it. The beautifying cosmetics for ladies to apply to the eyes, contain this substance, or an alkaloid called sulphate of atropia. The lady, however, who uses these to render her eyes sparkling at night, will, unfortunately, find she cannot thread her needle or read her novel the next day, nor for several days afterwards, and we trust the fright she will get will prevent her using them again. Why this is so we shall learn in a future article. Atropine is, however, one of the most important helps the oculist has to avail himself of, as we shall also see further on. The pupil is, as we said, a hole in the iris, and looks black,—just as a small hole in a closed box looks black. Atropine makes this hole larger, for the surgeon to look into the eyeball.

So far, your friend's face and eye have served to learn some anatomy and physiology from. For our further study you have the carefully drawn engravings accompanying this article.

In *Figure* 1, we look down on the eyeballs in their natural position in the orbits, such as a horizontal section of the skull just above them would show. The space between D and D is the cavity of the nose. The eyes are directed straightforward towards A A, the lines of vision. The lowest part of the picture represents the part just within the skull; you see the second pair of nerves coming from the brain, and notice that they join and decussate before each passes through the bone to enter the orbit at its posterior part, and go to the eyeball. These are the optic nerves, and carry the impressions of light made in the eye to the brain. The optic nerve within the orbit is long enough to allow the eyeballs to rotate in any direction on their centres, C C, to a certain extent. The eyeball is supported by a cushion of fat in the orbit, and lies, like a ball in a cup, upon a fibrous membrane that passes from the edges of the bony orbit round behind it. This membrane cannot, of course, be represented in this plate. Let us see now how the eyeball is moved. There are six muscles attached to it. Four of these are called the straight ones; they are fastened, as you notice, to the apex of the bony orbit, near where the optic nerve comes in, and are severally attached to the globe on the upper, inner, under, and outer side. In *Fig.* 1, you see three of them, *n*, *s*, *i*, the other one being underneath. The upper straight muscle is removed over one eye to disclose the optic nerve. In *Fig.* 2, you also see three of these straight muscles, the *outer* one being cut away to expose the rest, and the optic nerve. Another muscle marked *o*, in *Fig.* 1, is called the superior oblique. It is, you notice, attached close to where these are, and comes forward to the inner and upper part of the orbit, where it runs through a little pulley, and then goes underneath the upper straight muscle to the outer and back part of the globe. The sixth muscle is called the inferior oblique, which you can see in *Fig.* 2. It is attached to the inner and lower angle of the orbit, and runs to the under and back part of the globe. These six muscles act, therefore, in antagonistic pairs. While one is contracting to turn the globe, its fellow must relax to allow it so to do. The dotted lines, B and D, are the axes around which these muscles move the eyeball. We said the eyeball was imbedded in a cup-like membrane. The ends of these six muscles must, therefore, pass through this membrane to reach the globe. Modern surgery has shown the very frequent necessity of removing the eyeball to save the other eye. This is a much more simple operation than supposed, and the cup-like membrane is left with all the muscles attached to it. Now, when an artificial glass eye rests on this cup-like membrane, it will move so nearly the same as the eyeball, that it requires an experienced eye to detect a false one. In operating for squint, the surgeon cuts the muscle where it is fastened to the eyeball, just where the dotted lines, D D, *Fig.* 1, cross the internal straight muscle. The other muscle then turns the

Fig. 2. FROM NUNNELEY.



A, the cornea. *C*, the optic nerve passing into the orbit. *B*, apex of the orbit where the muscles are attached. *D*, the muscle which lifts the upper eyelid, hooked up. *E*, *F*, *G*, upper, inner, and lower straight muscles, the outer one, *H H*, having been cut away to show the optic nerve going to the eyeball. *I*, superior oblique muscle running through its pulley. *K*, the inferior oblique muscle attached to the orbit. *H*, the external straight muscle cut off at its attachment to the globe.

eye out straight, and the one we cut becomes again fastened to the eyeball.

The reader has learned something of the external appearance of the human eyeball and its surroundings. Let us study together the interior of the globe, and see if we cannot understand the wonderful structures there revealed to us. The eye of the ox or the pig sufficiently resembles the human visual organ to allow of its being used in dissection, to better comprehend the anatomy of this most interesting part of the animal economy. Recently removed, and examined in the fresh state, an animal's eye will teach us a great deal, and nothing repulsive will be found in considering its structures. If the reader has not time, opportunity, or desire to do this, the very carefully-drawn plates accompanying this article will answer, perhaps, even better, since each structure can be separately pointed out and described while the drawings are in front of him. Afterwards he can dissect some animal's eye, and see in nature the several parts. The eyes of fishes are well adapted to illustrate the anatomy of the visual organ, as everything is on such a large scale. The shark's, horse-mackerel's, sword-fish's, etc., are often to be obtained on our coast in the fishing villages. A seal's eye is particularly delicate and beautiful, to study the anatomy of the organ by.

Let us look now at the several coats of the human eyeball. In a previous picture you saw how the optic nerve entered the orbit and was connected with the globe of the eye, attached towards the inner side of the back of the eyeball. The protecting sheath of the nerve is, as you see in *Fig.* 3, continuous with the strong enveloping white fibrous coat called the sclerotic, and marked S in both figures. You see how this coat merges into the perfectly transparent cornea, or clear part of the eye in front. The sclerotic varies in animals from a thin, delicate, white fibrous membrane, to a very thick cartilaginous cup, or even a distinct bony shell, such as you will find in some fishes.

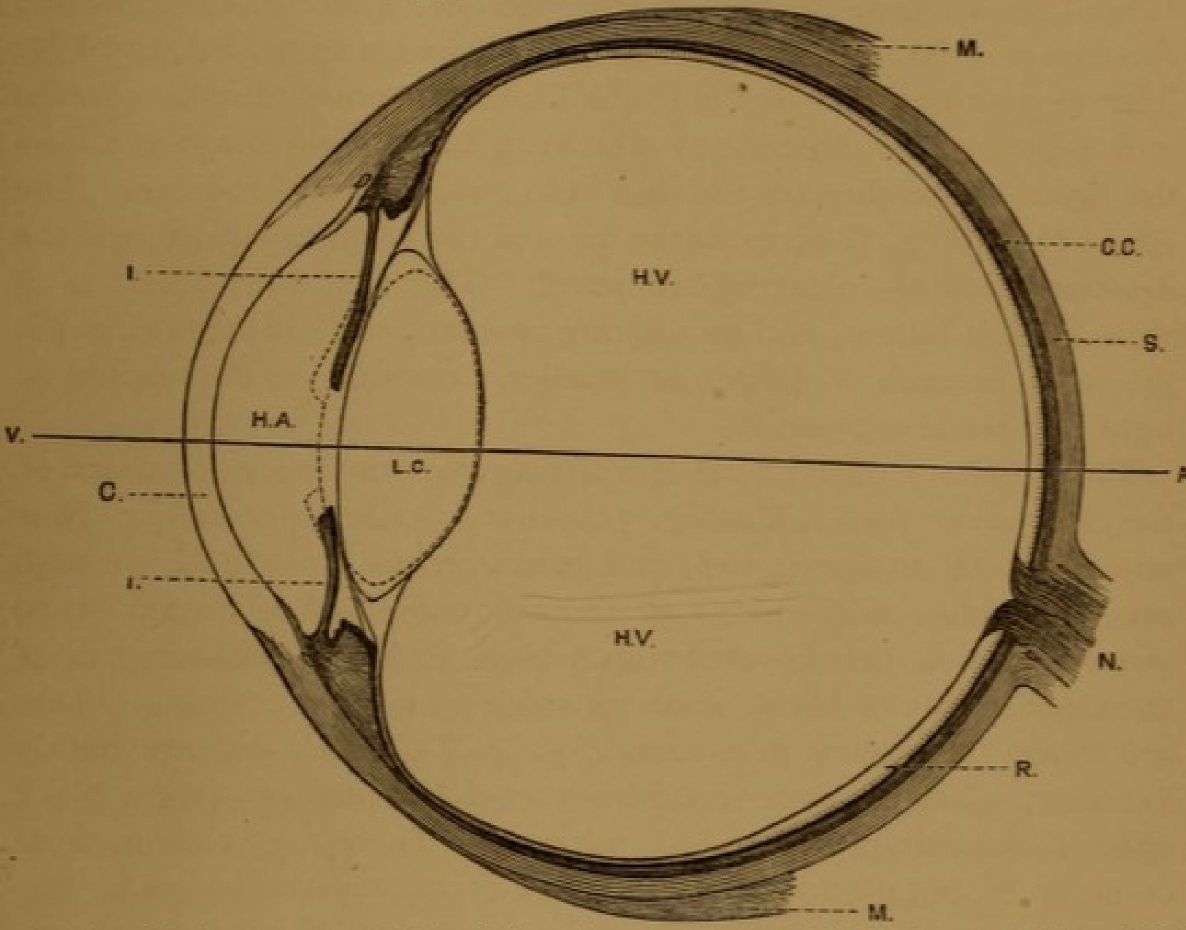
Next within the sclerotic lies the *choroid* coat, *Fig.* 3, C C, which is essentially a vascular membrane, made up of blood-vessels, coloring matter or black pigment, and some fibrous tissue. The meshes between the vessels are filled with this pigment, which is lighter or darker, according to the color of the animal or the race in man. The object of this pigment is to prevent the reflection of light, just as we blacken the inside of our optical instruments for the same purpose. On the inner surface of the choroid coat, next to the third coat, or retina, this pigment becomes arranged in a distinct and continuous layer, except where the optic nerve passes through it and the choroid coat, as you see in *Fig.* 3. This layer consists of minute hexagonal cells, as if they took the shape from mutual pressure, about one-thousandth of an inch in diameter, each with a transparent nucleus, and this surrounded with pure coloring matter, — making a very beautiful object under the microscope. Following, now, this choroid coat forwards to the anterior part of the globe, and we come to some of the most important parts, which we must closely examine to understand what may be seen.

We described the *iris*, or colored part of the eye, as a vascular and muscular membrane placed exactly like an optical diaphragm behind the cornea, attached to the sclerotic, where this merges into the cornea. It is shown in *Fig.* 3, I I, and *Fig.* 4, I A and I R. The posterior surface of the iris is like the choroid, thickly covered with pigment, the absence of which, in the albino animals, allows the light to pass directly through it to the interior of the eye. The space H A, *Fig.* 3, between the iris and the cornea, is filled with the *aqueous humor* — almost pure water. The iris thus floats, as it were, in this humor, and by dilating or contracting makes the pupil, the hole through it, larger or smaller, according to the amount of light the eye is exposed to.

The pupillary edge of the iris lies against the anterior surface of the *crystalline lens* L C, *Fig.* 3, to be described presently. Now when we cut an eye in two, and turn over the front half, we shall see surrounding this lens a radiated disk composed of from 60 to 80 minute folds, thickly covered with a black pigment, reminding us of the circular row of black seeds in some fruit or vegetable. These are called the *ciliary processes*, *Fig.* 4, P C, P C, and are highly vascular. They may be considered as a continuation of the black choroid coat lining the white sclerotic. Their free ends in front come up to, but do not touch, the edge of the crystalline lens.

Let us now examine this, the most important dioptical ocular apparatus, the *crystalline lens*, L C, *Fig.* 3. You see it lies just behind the iris, the edge of the pupil being in contact with it. The human lens is a double convex transparent body, about one-third of an inch in diameter, and one-fifth of an inch in thickness, much more convex on its posterior than its anterior surface. It is enclosed within a capsule of perfectly transparent material, which, although dense, allows fluid to pass through it. The proper structure of the lens itself varies with age, — in the infant it is soft as jelly, and in old age as hard as wax. With this increasing hardening of age there is a gradual change of the shape of the lens, it becomes flatter, and its two surfaces alter their relative curve. The lens in-

Fig. 3. FROM GIRAUD-TEULON.

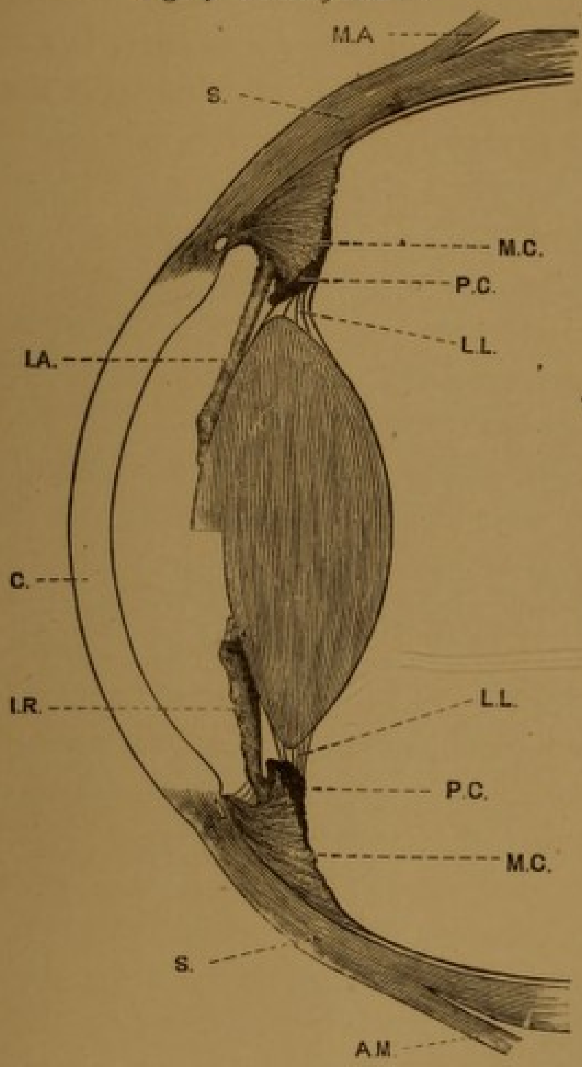


Section of the human eye carried through the optic nerve. The line *V A* is the the axis of vision. *M*, *M*, two of the straight muscles. *N*, optic nerve. *S*, sclerotic coat. *C*, its continuation, the cornea. *C C*, choroid coat. *R*, retina. *H V*, vitreous humor. *L C*, crystalline lens. *H A*, aqueous humor. *I*, *I*, the iris. The dotted lines show the position of the iris and the shape of the lens when the eye is accommodated.

creases in density as we go towards its centre. It is composed of fibres arranged side by side in concentric layers, and running from one pole to the other. These fibres are flattened, ribbon-like filaments, with interlocking serrations at their sides. The complexity of the arrangement of the fibres seems to be greatest in man, and less as we descend in the animal scale. You may have noticed how the crystalline lens of a boiled codfish, for instance, breaks up into segments and layers. There can be no doubt that this most beautiful and complex arrangement of structure serves to correct in the eye the faults we have to contend with in the glasses of our optical instruments. When this crystalline lens is *opaque*, it is called *cataract*, and the person cannot then see, because the light cannot pass through it to the inside of the eye. In children and young people, cataract is often soft, like sago or rice, and then when the oculist pricks the capsule which holds it, the aqueous humor runs in, and absorbs or melts it, and the patient will again gradually have sight. In old people cataract is hard, like wax, and the only safe way the oculist has of removing it is to cut a hole in the eyeball and take it out entire. Modern surgery has been quite successful in accomplishing this very delicate operation. People often mistake and speak of an opaque spot on the clear part of the eye, or cornea, as *cataract*, but cataract, as you see, is a very different thing. Most all of the quack eye-waters sold in the apothecaries' shops under one doctor's name or another's, contain *sugar of lead*. Now if the surface of the cornea is rough and abraded, as it is very apt to be in many diseases of the eye, a solution of sugar of lead put into the eye will finally make an opaque deposit of lead in the cornea, so that the unfortunate purchaser of these quack eye-waters is apt to be permanently more or less blind; the removal of this deposit by the oculist being difficult, and often impossible.

The crystalline lens has been called one of the humors of the eye. Behind and in contact with it is the third humor, called the *vitreous*, which may be described as a transparent jelly-like mass filling the interior of the eye, H V, *Fig.* 3. Its density is hardly greater than water, and it is composed of 98.40 parts of it. Anatomists and physiologists have thus far failed to make evident its structure. It is, in natural condition, sufficiently consistent to retain the impression of the lens, and the ciliary processes, when they are removed from it; some of the black pigment of the latter generally adheres to it. It is surrounded and enclosed by a delicate perfectly transparent glass-like membrane called the *hyaloid*, and this latter becomes of interest to us, as we shall now see. It is also called the *limiting membrane*, separating the retina from the vitreous. Where it comes round up to the ciliary processes, it divides into two layers, the posterior turns in and forms the concave anterior surface of the vitreous humor on which lies the crystalline lens, the anterior layer runs forward over the ciliary processes and passes to the anterior capsule of the lens, into which it is inserted. Cutting open a fresh eye, and looking into the front half, it will be seen as a zone around the lens. An old anatomist named Zinn discovered it, and it bears his name. The purpose of this structure being now known and understood, it has received a name which indicates its anatomical relation to the other parts, namely, *suspensory ligament of the lens*, L L, *Fig.* 4. By it the lens is held in its position and connected with the muscle marked M C, *Fig.* 4, to be presently described.

Fig. 4. FROM JÄGER.



Enlarged view of anterior half of the eyeball. *C*, the cornea. *S*, the sclerotic. *A M*, *M A*, attachment of two of the straight muscles. *L L*, suspensory ligament of the crystalline lens. *P C*, ciliary processes. *M C*, ciliary muscle. *I A*, iris, in accommodation. *I R*, iris, when eye at rest. The upper half of the figure, down to the break in the front surface of the crystalline lens, shows the eye when accommodated for diverging rays of light. The lower half of the figure shows the eye at rest; *i.e.*, adapted for parallel rays.

PHYSIOLOGY OF THE EYE.

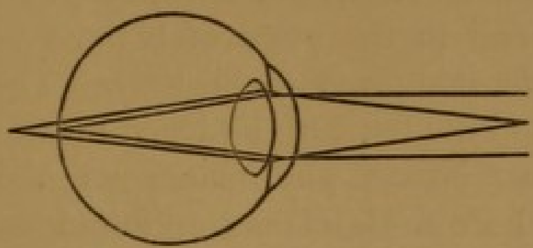
NOW let us here pause a minute and consider the aggregate of what has been so far described. The limpid aqueous humor contained within the perfectly transparent convex cornea, gives us a plano-convex lens. The iris lined with black pigment, and pierced with an opening, capable of alteration in size, represents an optical diaphragm. The crystalline, a double convex lens of greater density than the aqueous, behind the iris, completes the necessary optical apparatus to form a *camera obscura*, which the eye in reality is. A camera obscura is, as you know, an apparatus formed of a dark chamber, having an aperture in one of its walls, where is fitted a convex lens, and within the chamber is some appropriate surface on which will be painted, in inverted position, a perfect little picture of all outside objects within a certain range. Optically we may regard the cornea, aqueous humor, and lens, as one double convex lens. But where is the apparatus or membrane corresponding to the recipient surface of the *camera obscura?* It is the *retina*, R, *Fig.* 3, the true sentient portion of the organ of vision. It is called the third coat, and lies in contact with the limiting or hyaloid membrane we described, externally being against the pigment layer covering the dark choroid. It lines the interior of the globe up to the posterior end of the ciliary processes. In natural condition it is almost perfectly transparent, and will therefore allow the light coming into the pupil to pass through it to the pigment layer.

The optic nerve, N, *Fig.* 3, as it comes from the brain through the cranium into the orbit, and so to the eyeball, is a compact bundle of an innumerable number of nerve fibres. The mass of them together, where they enter the eyeball, form a round spot, called the optic papilla; from here the fibres pass off colorless, on the inner surface of the retina. More of them go towards the central point of the back of the eye, where the line V A, *Fig.* 3, strikes the retina, and where vision is best, and fewer and fewer towards the peripheric parts, as far forwards as the retina extends.

No greater mistake has been made than that of regarding the retina as a sort of expansion or spreading out of the fibres of the optic nerve. In reality the fibres of this nerve are merely the conductors from the retina to the *brain* of certain sensations, as the telegraph wires transmit thought. The optic nerve fibres do not receive the impression of light, but simply transmit it to the brain. If they did, then their aggregate, the optic papilla, where they pass out from the eye (N, *Fig.* 3), would be the most sentient part; but in reality this portion is insensible to light, and is the cause of the *blind spot*. To prove this, close your hands with thumbs up; hold the two thumb-nails side by side at arm's length, shut your left eye, and look steadily at your left thumb-nail with your right eye; now, keeping your eye fixed, move away the right thumb-nail from the other, and when the distance between the two is about six or seven inches, the right thumb-nail will suddenly disappear, to appear again when moved a little further on. The reason of this is, that the picture of the thumb-nail then falls on the optic nerve, where it enters the eyeball, and where, of course, there is no retina, only optic-nerve fibres bound up together like a skein of fine silk.

You have probably noticed that *Fig.* 4 is an enlarged picture of the front part of *Fig.* 3. By means of it we can study together one of the most perfect mechanisms in the human body, — to understand the necessity of which let us perform one or two simple little experiments.

Stand with your eyes about ten inches from a pane of glass that has dust on it, and look out of the window at distant objects. You will, of course, see everything quite plainly. Now, keeping your head in the same position, look at the particles of dust or dirt on the pane of glass. You will probably feel a sensation of effort in the eyes; and the nearer you bring your face to the glass the greater will be this feeling, till, finally, when too close, they all "blur." Now look off at the landscape again, and you will find there will be an appreciable time before objects look clear. Still another experiment. Stick three pins in a line on a board, at six, twelve, and eighteen inches, respectively, from the end of the board. Place your face at the end of the board, and look steadily at the head of either of the pins. The other two, you will find, are then blurred or indistinct. When you use your opera-glass, you find you have to screw it one way or the other, according as you are looking at near or distant objects. The eye has to be changed in the same way. Take a strong magnifying-glass in one hand and a white card in the other; stand a little way from the window, and let the light fall through the glass on to the card, and when you have got it at the right distance you will see a little bright picture of the window-sashes and the objects outside. This picture will be upside down; and, moving the glass a very little backwards or forwards, makes the picture blurred or indistinct. This is just such a picture as is painted on the retina in the human eye, as we said when comparing it with a *camera obscura*. Now, every illuminated point in nature sends out rays of light in all directions. Those rays which come from objects more distant than about twenty feet from the eye, may be considered as practically parallel so far as the eye is concerned. When the eye is at rest it is adapted to focus on the retina parallel rays of light. This little diagram shows you the parallel



rays focused on the back of the eye, such as come from distant objects. The *diverging* rays coming from nearer objects, you see, do not come to a focus till they are beyond the back of the eye or the retina. We should have to pull the retina back, or move the crystalline lens forward, or have the cornea more convex, or the crystalline lens more convex, to focus these diverging rays. Now what really takes place in the eye is, that the lens becomes more convex, which makes it stronger, or of shorter focus, as it is called. But when you looked at the pin eighteen inches from the eye in the board, you felt a certain effort, and then looking at the one at twelve inches there was more effort, and still more to see distinctly the pin at six inches. Therefore this change of the eye to adapt it to the more and more diverging rays from nearer and nearer objects, must be, like the screw of the opera-glass, capable of gradual change or adjustment. This power in the eye is called *accommodation*, and is caused by the lens changing its shape to a more convex one, as we have said. This change of shape is carefully illustrated in *Figs*. 3 and 4. In *Fig*. 3, the dotted line shows the outline of the lens when it is accommodated. When the eye accommodates itself to the diverging rays from near objects, the pupil becomes smaller.

The dotted line in *Fig*. 3 also shows the position of the iris in accommodation. We said the iris laid against the lens; when, therefore, this latter changes its shape, the iris must be pushed forward. In *Fig*. 4, I A shows the iris during accommodation, and I R when the eye is at rest. You notice there is a break in the front curve of the lens; the upper half of the figure represents the eye accommodated, and the lower half the eye at rest. This change in the lens is effected by its own elasticity when the suspensory ligament we spoke of (L L, *Fig*. 4) is slackened up, as seen in the upper L L.

In *Fig*. 4, M C, M C represents a muscle called the *ciliary muscle*, which is attached to the sclerotic just where this merges into the cornea, towards which point it pulls when contracting, thereby slackening up the ciliary ligament compressing the lens, which, from its natural elasticity, takes at once a more convex shape, thus perfectly adapting the eye to focus on its retina, diverging rays of light coming from near objects. Now hold between your eye and a friend's a lighted candle, and in the pupil of his eye you will see two, or perhaps three, little images of the candle. These come from the cornea, the front and the back of the lens. It was by studying these images that three German physicians, — Dr. Max Langenbeck, Prof. Donders, and Prof. Helmholtz, — found out how the eye was accommodated; and although it was published, and mathematically demonstrated, in 1857, you will rarely to-day find it in the works on optics studied at our universities and schools.

OLD SIGHT AND SPECTACLES.

IF the reader has studied the previous chapters he will be able to follow us understandingly, whilst we speak about old sight and spectacles. You learned how the eye adapted itself to see near as well as distant objects. This adaptation, or *accommodation*, as it is called, we compared to the screw on an opera-glass, which adjusts the focus to the distance of the object we are looking at. The accommodation we showed was accomplished by the lens changing its shape, and this it does from its own elasticity, when the ciliary muscle, by contracting, slackens up the suspensory ligament of the lens. We also saw that the eye had the power of *gradual* adjustment, precisely as we can turn the screw of the opera-glass, or push in or out the tube of the spy-glass or microscope. The use of the eyes, therefore, to see near objects, in reading, for instance, is a muscular effort, and consequently subject to the general laws which govern muscular activity. This at once explains to you what the eye "*feeling tired*" means. You can hold out at arm's length a half-pound weight without fatigue for a certain length of time, but beyond a certain length of time it is impossible. Exactly the same with the use of the eyes in reading, for instance; the muscular effort of accommodation is exercised almost without sensation, till pushed beyond its power, when the ciliary muscle suddenly ceases to act, and the lens to be changed in shape, the consequence of which is that the letters run together, or are blurred, because the picture on the retina is not sharply defined; in other words, out of focus. The muscular effort, then, to adjust our eye, is accompanied with fatigue, and, if pushed further, with pain; we are forced to stop and rest. Now although man's most complete bodily development is at about 30 years of age, this muscular power of adjustment or accommodation is greatest in childhood, at about 10 years of age, and becomes gradually less with advancing years, not perhaps due so much to want of power in the ciliary muscle as to the lens becoming less elastic, and thus not so readily or perfectly assuming a more convex shape when the pressure on it by the ligament is relaxed We know that in infancy the lens is almost like jelly, and in old age as hard as wax.

This gradual loss of the power of accommodation is not naturally noticed till it is sufficient to affect our ordinary occupations, such as reading, sewing, writing, and other fine work; this it does generally somewhere between 40 and 45 years of age. Then we see our friends holding the newspaper further off, turning their backs to the window to get a brighter reflection from the page, thereby causing the pupil to close more, and thus cut off the outer rays. After the fatigue of the day the evening paper cannot be read with ease, as before; the letters run together, and the eyes are tired and painful. After a few minutes' rest the paper can be read, but again soon blurs. This is the commencement of "old sight," which does not come suddenly, as often supposed, but is only noticed when it arrives at that degree which affects our ordinary occupations. This loss of accommodation goes gradually on till we cannot see any near objects, while the power for distant vision remains as in childhood, or but little impaired, because, as seen in *Fig.* 1, the rays from distant

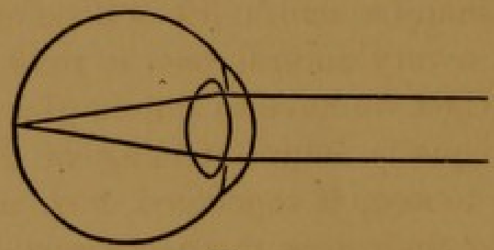


Fig. 1.

objects are parallel, and the eye focuses them on the retina without the necessity of accommodation.

The highest authority on this subject—Prof. Donders—says, that our social condition requires that we should often be engaged in reading, writing, or other close work. It is plain that the average magnitude of the forms employed in such work is closely connected with the accuracy of the power of vision, and with the distance of distinct vision for the normal eye. The same is true of the productions of art, and of a number of trades. What the human eye, in the full power of life, can do, has in general afforded the standard for this. Before the application of spectacles the standard was undoubtedly different. If these instruments were no longer to be obtained by all, a larger type in general should replace that at present in use. The common employment of spectacles has, therefore, exercised an influence on the limits of distinct vision, with which we must allow old sight, or *presbyopia*, to commence. The changeableness of these limits thus appears most prominently. We have to investigate how long the eye fulfils the requirements of the assumed standard. Even in the thirtieth year the normal eye dislikes the small print, which the near-sighted person prefers, and youth does not avoid. Still, in the fortieth year, ordinary type presents no difficulty whatever to the emmetropic or normal eye. In the fortyfifth year the notes, printed in smaller characters, are not unfrequently passed over, and the book is in the evening probably somewhat earlier laid aside. We now begin to observe, that an object, to be very acutely seen, is removed a little further from the eye; a clear light is also sought, rather for the purpose of diminishing the circles of diffusion on the retina in imperfect accommodation, by narrowing the pupil, than of obtaining more brilliantly-illuminated images. Ordinary occupations are, however, still performed uninterruptedly without remarkable exertion. But when minute matters, which now and then occur, are to be accurately seen, comes the complaint, however unwillingly from the lips, that our eyes are no longer what they were.

Here, then, commences not old age, but old sight, or presbyopia. The best work of many a man's life is done after he has put on glasses. The idea, a very natural one, it must be confessed, that we are getting old when we have to put on glasses for ordinary occupations, and the equally natural feeling of desiring to resist or push off old age, or to keep it concealed, has, and will always, deter many from giving their eyes the neccessary help which spectacles alone afford. If suddenly all print and writing, and every form of fine work, should be changed to two or three times finer, then the necessity for glasses would come at twenty-five to thirty years, and this then would be old age. For, as previously shown, the power of accommodation required to adjust the eyes for near or fine work, is in reality greatest at about ten years of age, and commences to fade from that time forward. Therefore, so far as it is concerned, old age would then begin. Hence the absurdity of feeling chagrined by, or regarding the use of spectacles as a proof of old age, or a fading from the highest attainable strength and activity man can possess. Let it therefore be understood that by old sight, or presbyopia, is meant, that the natural change, or gradual loss of accommodation of the eye, has simply reached the stage when it commences to interfere with distinct and easy vision of the smaller objects which are of the size habit and custom have made them, based upon the general average of the normal power of sight. It is no sudden change, or loss of vital power, but a simple reminder that we have arrived at a certain age, as a poll-tax bill notifies the younger man he is responsible for himself, and has become a citizen.

It is therefore a perfectly healthy and normal eye which, between the ages of forty and forty-five, is obliged to be assisted by a glass. It cannot go many years beyond this time unaided, without risk of injury, and straining the power of sight. How is it, then, that many people, as we know, succeed in putting off the wearing of spectacles to a later age, when, perhaps, their eyes are *apparently* normal, or, at any rate, healthy, and have not troubled them through life? There are several reasons for this, easily explainable. Some of our friends will boast, they are fifty years old and never have worn glasses. If, however, you watch them, you will find they do no night work, and confine their newspaper reading to bright day-light, with the sheet held well off from the eye, and prefer the leaded leading articles. Paper-covered novels, and such "poor print," are carefully avoided. There are many such people who, from a foolish sensitiveness, are laying up future trouble for themselves, by refusing the aids which nature demands and science provides. In many of the mechanical employments, by the time accommodation has failed to the extent of constituting old sight, or presbyopia, the artisan has learned his special trade so as to be able to do his work without the acute vision he required when younger. Should he attempt to change his occupation, or turn to finer objects, his loss of youthful eyes would soon be apparent. Another point is this: when the pupil, as is sometimes the case, is unusually small, and decreases in size with age, then the necessity for glasses is not so soon experienced, since the outer rays are cut off, and the central ones are focused sufficiently well on the retina to afford good sight. Any one who wears even a pretty strong glass will be able to see near objects through a pin-hole in a card without the glass. Thus, also, is simply explained the reason why some old people are enabled to leave off their glasses which they had worn for years. The pupil has become extremely small, perhaps no larger than the head of a pin. These central rays are practically parallel, and, as is seen by *Fig.* 1, parallel rays become properly focused on the retina without the necessity of a glass in front of the eye.

So far we have been speaking of a perfectly normal eye gradually losing its power of accommodation, and so requiring the assistance of a glass. There are, however, two conditions arising from disease, one of which *prevents* the accustomed use of convex glasses, and the other necessitates their being *stronger* and *stronger*. These conditions we must here explain, since it is of considerable importance that they should be understood, as thus much danger to the eyesight may be avoided. The first of these morbid states is *cataract*; that is, a gradual opacity of the crystalline lens. Now, when cataract commences, the crystalline lens swells up and becomes thicker, which is exactly what it does every time we look at near objects, or, in other words, accommodate. This will be readily understood by referring back to the diagrams explaining this action in the eye. This gradual swelling of the lens is, of course, permanent, whilst, ordinarily, the lens resumes its flatter shape when we cease to look at a near object, and gaze in the distance. Now we needed a glass because the eye had failed to accommodate. If it is continuously accommodated, the glass may be dispensed with. Moreover, if the lens swells considerably before becoming opaque in the centre, then not only will the *convex* glass the person had been using have to be laid aside, but it will be found that their sight is improved by *concave*, or near-sighted glasses. The ophthalmic surgeon often receives a letter from a patient, or his family physician, in which this *wonderful* change of the eye is more or less scientifically recorded, and its meaning asked for. *Commencing cataract* he can at once reply is the disease, to be cured only by an operation when the cataract is "ripe."

The other morbid condition, which requires stronger and stronger glasses to be used, is what we call *glaucoma*, which we shall more fully explain when describing the operation for *artificial pupil*, that alone can save the eye attacked by this fearful disease, the cause of so many losing their sight forever. A person in middle age, or older, finds he must change his glasses for stronger ones, which do not last but a few months before resort must again be had to a still stronger pair. Pain and disturbance of vision now, perhaps, warn him that all is not right with his eyes, and he seeks medical advice, fortunate if some meddling friend has not persuaded him to apply to this or that advertising charlatan or licensed quack, who will agree to cure him for so much money down, or so much a month, and warns him (if a poor person) against going to a charitable eye hospitable, "because they will operate on him"; or (if a wealthy client) persuades him that by following his advice he will recover at half the cost of any ophthalmic surgeon's fee. Finally, when sight has nearly gone, patience and purse exhausted, and the best, or perhaps only chance, for a curative operation passed by, the unfortunate patient applies to some regular ophthalmic surgeon, who readily detects *chronic glaucoma*. Then, very likely for the first time, the patient learns what advertising and licensed quacks are, and how he has, by them, been cheated of his money, and most probably, also, of the opportunity for a timely operation, by which alone the loss of sight could have been saved.

Now, then, our readers understand how very old people may see without their glasses; also how middle-aged or old people may find they can get on without them, which may indicate commencing cataract; and again, how the necessity for repeated change to stronger and stronger glasses may mean the coming on of one of the most dangerous diseases for the sight of the eye, namely, *glaucoma*. It is perhaps proper to mention here, that *acute* glaucoma may produce very sudden blindness within a few hours; and, curiously enough, the more acute the disease, the more sure will an *immediate* operation for artificial pupil, called an iridectomy, cure it, and save the sight of the eye.

Let us, however, here return to the question of the choice of glasses. A good many people find they can avoid their use to a considerably later period in life than others, on which they congratulate themselves as having extra strong eyes. The truth is, they are, and have always been, a little near-sighted; this, if suggested by the ophthalmic surgeon to whom they have applied, they indignantly deny, till, upon looking through the near-sighted or concave glasses he selects for them, they find, to their surprise, they can read the letters of his test types across the room as they never could before, and as they cannot without these glasses. The perfectly healthy normal eye, however, begins to need a glass for ordinary work at between forty and forty-five years of age, — of course we here exclude all debilitated conditions of the body resulting from disease. Now, then, comes the question, shall we put on glasses, and of what strength? To answer some prevalent fallacies handed down from one generation to another, we cannot do better than quote from the highest authority, Prof. Donders, who says: "The opinion is rather general, that we should refrain as long as possible from the use of convex glasses. But is it not folly to weary the eyes and the mind together, without necessity, condemning ourselves to guess, with much trouble, at the forms which we could see pretty well with glasses?" We have here to do with a prejudice which, perhaps, finds some support in vanity. It is asserted, practice of accommodation is desirable. Generally speaking, this is perfectly true. To look alternately at distant and at near objects, now to occupy one's self with smaller, and now with larger objects, develops and maintains the functions of the eye. But we forget that we were obliged to practise more and more as years have rolled on, and that, by these efforts, increasingly necessitated by the diminishing range of accommodation, the power of using a great part of this latter has already been acquired. Is it not, therefore, evidently absurd to commence, at nearly fifty years of age, a more powerful gymnastic system than youth was ever called to?

Strangely enough, people have fallen, also, into the opposite fault. Some have thought, by the early use of spectacles, to be able to preserve their power of vision; and have recommended and employed "conservative glasses." If I am not mistaken, self-interest had something to do with this recommendation. So long as the eye does not err, and remains free from fatigue in the work required of it, its own power is sufficient, and it is inexpedient to seek assistance in the use of convex glasses. Light-blue spectacles, also, which have been sometimes recommended as "conservative spectacles," are, under ordinary circumstances, objectionable for a healthy visual organ. Most eyes find their soothing influence agreeable, and people are therefore readily inclined to employ them. But, while they withhold from the retina the ordinary stimulus of white light, they increase its sensibility beyond the normal, and create a permanent necessity for their employment. Now a more than normal sensibility is an inconvenience, and, at the same time, predetermines to disease.

Our readers will say, this is very clear, and readily understood; but having made up their mind that they require glasses, how are they to know what glasses to procure, or what number is correct? Generally, people go to the nearest spectacle vendor, and purchase what they see best with at the time. Concerning this method, we shall have something to say in the next article. We say here, distinctly, once for all, that the ophthalmic surgeon is the one to be consulted as to the wearing of glasses. He, by testing the eye, can alone decide whether any and what glass should be worn. Opticians and spectacle vendors know nothing about the laws which govern the refraction and accommodation of the eye. It is not their business, any more than it is the apothecary's to know about diseases. Now, for the ophthalmic surgeon it is quite easy to decide whether convex glasses should be worn, but it is not so easy to decide exactly of what strength or focus these should be. It is true, the power of accommodation gradually fails with age, and therefore this would naturally decide the number of the glass required, and this, therefore, can be given in tabular form. A perfectly healthy and strong eye, as age comes on, needs *about* the glass here indicated, for writing, and for reading ordinary type. Glasses are numbered by the number of inches of the radius of the wheel on which they are ground, which is their focal length.

Age.	Convex Glasses required.	Distance of Distinct Vision in Inches.
40 } 48 }	60	14
50	40	14
55	30	14
58	22	13
60	18	13
62	14	13
65	13	12
70	10	10
75	9	9
78	8	8
80	7	7

The chances are, however, that, should any one, feeling they required convex glasses, select them by this table, they would not choose the power which their eyes required, as there are a variety of circumstances which govern the ophthalmic surgeon in his selection for his patient, and these cannot be neglected. He has to take into consideration any diminished acuteness of vision, or any disturbance of accommodation, from whatever cause. We have already spoken of the influence of commencing cataract and glaucoma. The nature of the patient's work has to be considered. For instance, as to writing, whether this is to be a fine hand or in large registers; as to reading, whether this is fine type, or difficult, like German text, or whether it is pulpit-reading; as to money-sorting, whether only the denomination is to be seen, or the finer marks, used to detect counterfeits; as to occupation, whether engraving, watch-repairing, or minute drawing, etc; as to whether work is day or night-work, or both. It will be thus seen that there are very many circumstances which must absolutely be thought of and understood, in what, at first sight, seems so simple, namely, the selecting a proper pair of spectacles. This is all in reference to the strength of the glass, but other points must also be decided upon as well. Some of these are, whether the patient can or should wear springs or spectacle frames, what the shape of the glasses should be, round or oval, and how large, as well as how adapted to the nose. As we have to use stronger and stronger glasses, the first, or weaker ones, should be kept for day-work, and the higher, or stronger ones, for night-work. The advice of the ophthalmic surgeon will also be found invaluable as to how to wear glasses, whether springs or spectacles, so as not to fatigue the eyes by straining them from improper use of these invaluable aids to man's happiness. We conclude by saying, that all advice in this article applies only *to those having normal, healthy, strong eyes.*

NEAR-SIGHTEDNESS, OR MYOPIA.

SO far, we have been studying the refraction and accommodation of the normal eye, and its natural change from advancing years. Now let us see what a *near-sighted*, or *myopic* eye is, and what can be done for it. *Fig.* 1 is a diagram of a near-sighted eye. You

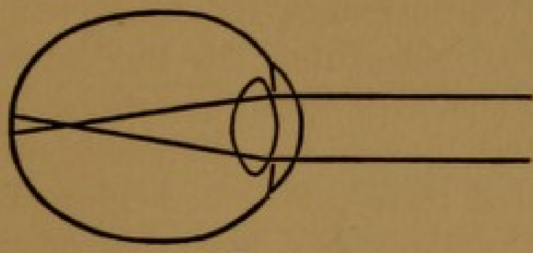


Fig. 1.

see the front part of it, the lens, etc., is the same as a normal eye, as in *Fig.* 1, in the previous article. But the back part of the eye is elongated, giving the eyeball an egg shape. Hence the parallel rays of light from distant objects come to a focus in front of the retina. There the rays cross and reach the retina so as to give a confused picture. Rays of light coming from near objects are diverging, and these the near-sighted eye can focus on its retina. The longer, or more egg-shaped the eye, the more short-sighted it is, and the nearer must objects be brought to be distinctly seen. Now, if we can make the parallel rays of light from distant objects *diverging*, before they come to the eye, then they will also be focused on the retina. This we can do by a concave glass, which spreads them out, as you see in *Fig.* 2. You notice this eye has exactly the same shape as in *Fig.* 1. The glass renders it capable of seeing

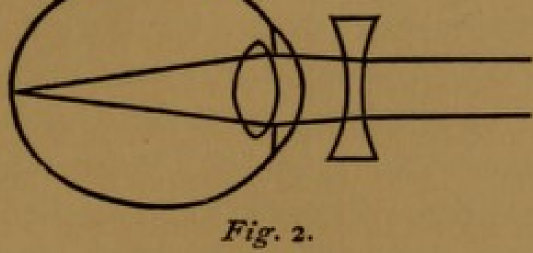


Fig. 2.

distant objects, and its own power of accommodation, just as in the normal eye, enables it to adapt itself to near objects.

It is already several years since Prof. Donders unhesitatingly declared that a near-sighted eye was a diseased one. His studies of refraction and accommodation are now, so to speak, the classical literature of this specialty. It is the duty of all ophthalmic surgeons to render them of service to the communities in which they live, by continually bringing before them the necessity and value of a thorough scientific investigation of the refractive condition of every eye not perfectly normal. For it is in this way alone the laity can be brought to recognize the need of applying to the professional specialist, to have errors of refraction or accommodation corrected by the means modern science has placed within our reach. This seems so self-evident that it might, at first sight, be regarded as needlessly said; but how many people here in New England, as well as all over this country, either of their own accord, or, perhaps, directed by their family physician, purchase spectacles at the village clockmaker's, the village toy-shop, or of the travelling pedlar, and the peripatetic quack oculist! Naturally it will be a long time before our community learns that it is not a necessary part of every watchmaker or repairer's business to keep on hand and sell spectacles, which, according to his degree of honesty, or "brass," he advertises as "helps to read," or "restorers of sight," etc. The amount of injury done by this special form of quackery is not generally known, but abundantly proved by the daily records of the eye hospitals of our larger cities. Oculist and optician are regarded as synonymous terms by nearly all classes of the community, and ophthalmic surgeons fail in their duty if they do not teach them that an ophthalmic surgeon alone can make a proper and correct examination of the human eye, and decide what glass, and whether any, should be worn by the patient, and the *optician's* business should be confined entirely to preparing and setting in a proper frame the glass directed by the former; exactly as an apothecary compounds and puts up the medicine prescribed by the physician. An honest and intelligent optician would no more think of substituting another for the glass written for by the surgeon, than the druggist would of altering the physician's prescription. Now, we do not suppose that any amount of teaching or explanation will ever prevent a certain class of the community from applying to those who sell spectacles, and allowing them to choose for them, any more than we suppose that apothecaries and druggists will cease to be applied to for "something good for summer complaint," "a cold," "children's fits," or "liver complaint," or cease to sell the applicant the last quack compound. But that apothecaries *should* prescribe quack medicines we do not admit, any more than that watchmakers and jewellers, as a class, know anything about physiological optics, or are competent to select proper spectacles for those applying to them. Moreover, from the personal experience of others, as well as that of our own, we would unreservedly say that the community would save money by *first* applying to the ophthalmic surgeon, and, where that cannot be done, to the charitable infirmaries now established in our larger cities.

There are some popular delusions and mistakes to be noticed, here, in reference to near-sightedness, or *myopia*, as oculists call it. In the first place, a short-sighted person is congratulated that he will have good eyes in old age, and not need to wear glasses. This is a mistake; they will always have to wear glasses to see distinctly in the distance; if, however, they have been accustomed to wear spectacles, they will instinctively, as age comes on, push them up on to the forehead when eating their dinner, or, perhaps, reading, etc. Another fallacy is, that a near-sighted eye is always a strong one. Now there are many near-sighted persons, born so, who go through life wearing the appropriate glasses, and using their eyes as freely, and with as little concern or consequence, as any other person. This may be called fixed myopia, and is hereditary,—the girls generally following the mother, and the boys the father, as respects their sight. Where, however, near-sightedness comes on in youth and increases, or increases from birth, then it is a very serious trouble, and often leads to total blindness. The use of the eyes for near objects increases near-sightedness, which may be due to the bulging out of the back part of the eyeball. Bending over the desk or piano is very bad for near-sighted people. What we said in reference to the selection of spectacles, applies still more strongly here. The striving for a higher and higher standard of education is the cause of the increasing number of near-sighted people in our communities. It is difficult to lay down any definite rule as to the use of spectacles. Every person whose eyes are not normal had better consult some scientific oculist, avoiding all travelling quacks, and every doctor who advertises in any shape whatever. People only slightly near-sighted may go without glasses, taking care to hold the book up, and not bend over it, or the desk. People considerably near-sighted had better wear appropriate glasses for *convenience* and *safety*. Those very near-sighted, especially if increasing, should never wear glasses, except ordered by a scientific oculist. They never should select them themselves. It will be better to let the physician consulted choose the profession or occupation for a very near-sighted person, than to have the eyes break down, or partial blindness come on after a profession is learned.

The truth is, each case of near-sightedness is one by itself, requiring precisely the right glass, or perhaps one glass for distance, and a different one for near objects. With appropriate glasses, many near-sighted or myopic people manage to get along in life about as well as other people; upon testing, however, they will be found not to have the same power of vision as those with normal eyes, at which they are often as much surprised as people are upon finding they are color-blind. What we want here to emphasize and dwell upon, however, is the fact that the number of strong and healthy eyes among myopic people is not as large as supposed, and improper glasses, improperly used, diminishes this number constantly. We said above, that the demands of present education increased the number of people with acquired myopia, or, in other words, impaired vision. This is well known, and recognized by every ophthalmic surgeon having an extensive practice among our highest educated communities. No one has yet, however, in this country, followed up a series of continued investigations, so as absolutely to prove it. Abroad, however, this has been done, and with the development of such startling data, that we give them here, since they must interest us all. Scientific research in this direction has lately been followed out so thoroughly, and with such important results, as to merit the attention of every one connected with the education of the young, as well as the special interest of the ophthalmic surgeon.

Dr. Cohn, of Breslau, has recently carefully examined the refractive condition of the eyes of 10,060 children, in the lower, middle, and upper schools of Breslau, and other places in Silesia. We should premise by saying, that he was induced to undertake this great task from finding, whilst at work on the statistics of some fifteen thousand patients of Prof. Forster's clinic, that out of 750 near-sighted people who presented themselves within four years, 400 had applied on account of severe trouble dependent on near-sightedness. Desirous of finding whether the refractive and other troubles of the eye were not induced by inadequate and improper light, badly-arranged and badly-planned school-desks, etc., he first examined the schools in Breslau, and, to avoid errors, afterwards those of other places in Silesia, not content till his lists contained over 10,000 records. His example is, fortunately, now being followed by competent observers in various parts of Germany.

Dr. Cohn chose 5 village schools, with 1,486 scholars, and 28 city schools, with 8,574 scholars; of these latter, 20 were elementary, 2 intermediate, 2 girls' high, 2 where languages and science were taught, and 2 upper high schools. Among the 10,000 children he found 1,730 with defective vision, making 17.1 per cent., the average number *increasing with the degree of demand upon the eyes at school.* In the city schools, there were four times as many children with defective vision as in the country. With regard to sex,—boys, 18.8, and girls, 14.3 per cent. The relation of defective vision to abnormal refraction is shown by the following table:

Normal Eyes	8,330	83 per cent.
Abnormal Refraction	1,334	13 " "
Other Affections	296	4 " "
	10,060	100

Thus showing three times as many cases of abnormal refraction as other troubles with the eye in youth. Of these 1,334, one thousand and four (1,004) were near-sighted. The following are deductions from his data in reference to near-sightedness: "1. No school was without myopic scholars. 2. The number varied greatly in the different schools. 3. In the village schools, very few (1.4 per cent). 4. In city schools, eight times as many (11.4 per cent). 5. In the city elementary schools, four to five times as many as in village (6.7 per cent). 6. Girls' high school more than the elementary (7.7 per cent). 7. In the city schools, there is a steady increase of the number of near-sighted children from the lower to the upper. 8. In the middle schools, one-tenth, and more, in the next above, one-fifth, and in the highest, more than one-fourth of the children are near-sighted. 9. The number of myopes varies in the different village schools, and also in the upper schools, the greatest variation, however, being in the different elementary schools."

If all this is not sufficient proof that the greater tax upon the eyes increases near-sightedness, let us follow these young persons as they grow older. Dr. Cohn examined 410 of 964 students at the Breslau University,—without selection, however. Among these 410, not *one-third* had normal eyes, and nearly *two-thirds* were short-sighted. His data showed this trouble to be the most frequent affection of the eye among students, and that it increased with the age, and number of terms, of student-life.

Let us see, now, how it is with the *spectacles* of these near-sighted youths, of both sexes, even in the land from which almost all our knowledge of the refraction and accommodation of the human eye comes. Dr. Cohn found only 107 wearing glasses. Of these, only 8 had been ordered by a physician, the other 99 bought by the children on their own selection. Some had changed the glasses prescribed for them by a physician, for stronger ones. Of the 107, only 26 neutralized the near-sightedness, 41 were weaker, 40 stronger than the myopia. Only *eleven* out of the whole number had concave glasses that were not injurious. Well might Dr. Cohn say, "If I accomplished nothing else by my whole labor, than that hereafter no scholar wore a glass except by the ophthalmic surgeon's advice, I should feel amply rewarded."

These data led Dr. Cohn to endeavor to ascertain what there was in the schools which originated or increased near-sightedness. He had taken the bodily measurement of these 10,060 children, and measured in comparison the school-desks and seats, from which he found that all school-furniture was badly constructed, so as readily to induce or increase near-sightedness. From the furniture not being adapted to the body of the children, they are obliged to bend the head over forward, thereby hindering the return of the blood from the eye, and to keep the print so near (3 to 4 inches) as greatly to task the power of accommodation. Now both of these, we know, induce near-sightedness. Inadequate light, and misplaced windows, Dr. Cohn found greatly affecting the amount of myopia amongst the pupils of the school, as also inadequate and badly-arranged artificial light, where used.

Now, then, comes the question whether any of these causes can be prevented or removed. If so, certainly it is our duty to teach the community what they ought to do, and how. First, then, in regard to near-sightedness itself. Prof. Donders has said, "the cure of near-sightedness belongs to the *piis desideriis*. The greater our knowledge of the causes of this anomaly, the less seems even any future hope of our curing it." For, as Dr. Cohn, with truth, says, we cannot shorten the too long axis of the eye, or reduce the bulging of the posterior pole of the globe. But we can do a great deal to prevent near-sightedness developing in those prone to it, and check it where progressive, by adequate illumination, natural and artificial, not forcing the scholars, proper type and impression, and, most of all, by seats and desks appropriately constructed. We sent from America, with considerable pride, our school furniture and appurtenances to the last World's Fair, at Paris. These were carefully examined and measured by Dr. Cohn; and, like all the others, found so arranged as to produce these evils we are speaking of, as he has shown in an article entitled "The School-houses at the Paris Exposition from a Hygienic Point of View."

We said above, that near-sightedness coming on in youth, and increasing, was due to the bulging of the back part of the eye. By looking at *Fig.* 1, it will be seen that the more the eye gives away or bulges, the greater will be the length of the eye, and, consequently, the more myopic the patient, who will need stronger and stronger glasses. Here again we quote from Prof. Donders, as every ophthalmic surgeon recognizes the truth of his remarks. He says, "The same causes which give rise to near-sightedness are still more favorable to its further development. I have always with great care watched the course of myopia. I attach to it a special importance. The well-known fact that near-sighted people with little light can recognize small objects, and especially the circumstance that at an advanced period of life they need no glasses to enable them to see *near* objects, procured almost general acceptance for the prejudice that near-sighted eyes are to be considered as particularly strong. Many medical men even participate in this error. But the oculist has only too often been convinced, by sad experience, of the contrary. I have no hesitation in saying that a near-sighted eye is not a sound eye. In it there exists more than a simple anomaly of refraction. The *optical* characteristic of myopia may consist in this: the *anatomical* is a prolongation of the visual axis, and the latter depends upon a morbid extension of the membranes. If this extension has attained to a certain degree, the membranes are so attenuated, and the resistance is so diminished, that the extension cannot remain stationary, the less so because in the myopic eye the pressure of the fluids is usually increased. In this progression, extensive *progressive myopia* is included, which is a true disease of the eye.

"From what has been said, therefore, it will be easily understood that high degrees of myopia are less likely to remain stationary than slight degrees; and at a more advanced time of life they may continue to be developed, with increasing atrophy of the membranes. In youth, myopia is almost always progressive; the increase is then often combined with symptoms of irritation. This is the critical period for the myopic eye; if the myopia does not increase too much, it may remain stationary, and may even decrease in advanced age; if it is developed in a high degree, it is subsequently difficult to set bounds to it. At this period, therefore, the above-mentioned promoting causes should be especially avoided. On this point I cannot lay sufficient stress. Every progressive myopia is threatening with respect to the future. If it continues progressive, the eye will soon, with troublesome symptoms, become less available, and, not unfrequently, at the age of fifty or sixty, if not much earlier, the power of vision is irrevocably lost, whether through separation of the retina from the choroid, from effusion of blood, or from atrophy and degeneration of the yellow spot, or the central point of best vision in the retina."

Now, then, our readers understand that there is a disease which affects the back of the eyeball causing it to bulge, and so produces increasing and dangerous near-sightedness, and that all occupations which try the eyes help to hurry this forward. The wearing of appropriate glasses is the first means to ward this off, and only an ophthalmic surgeon can select these properly. Moreover, there are certain visible changes that take place in the back of the eye, which the physician can see by means of his ophthalmoscopic mirror, and he can judge, on examination, whether the near-sightedness is *stationary*, and not dangerous, or *progressive*, and liable to lead, as only too often it does, to partial or total blindness. Here it is interesting to see how Dr. Cohn's investigations completely confirm Prof. Donders's views, above expressed. He examined the relation of myopia to this bulging of the posterior pole of the eyeball, called by oculists *staphyloma posticum*. Of the one thousand and four myopic children, two hundred had this bulging of the globe behind, readily seen through the ophthalmoscope, the number increasing with the age. The *greater the degree* of myopia, the more *frequent* is this peculiar giving way of the eyeball.

We should here finally remark, that besides the selection of the proper glasses, which is of the first importance for the patient, the surgeon is now enabled in these cases to carry out a considerable degree of treatment that has been found of value in arresting or delaying impending loss of sight, or blindness.

LONG-SIGHTEDNESS OR OVER-SIGHTEDNESS—HYPERMETROPIA.

DURING the past few years, modern science and research has shown that there is a condition of the eye exactly the reverse of what we described in the previous article; namely, over-sightedness, or hypermetropia. It is a source of much evil when not understood, and corrected by the proper spectacles. *Fig.* 1 is a diagram of such

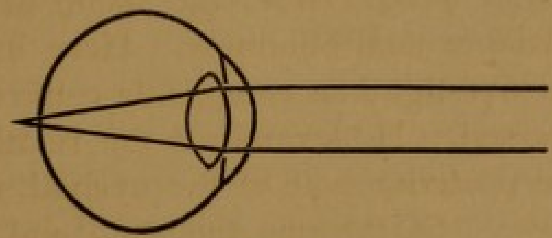


Fig. 1.

an eye, which is so from birth, and does not increase with old age, but is, of course, subject to the same change as a normal eye undergoes with years. You will notice this eye is the reverse of the myopic one, *Figs.* 1 and 2 in the previous chapters; it is flatter, even, than the normal one. Hence, unlike the normal eye, it cannot, when quiet, even focus the parallel rays from distant objects on the retina, and they fall behind it, as you see in *Fig.* 1. They must be made converging, in order to focus on the retina, and without a glass this can only be done by the shape of the lens being changed through *accommodation*. Now if the eye has to accommodate for distant objects, it will, of course, have to do much more so for near objects. The muscular effort of accommodation will soon fail, and give rise to what is known as "weak eyes." Look, however, now, at *Fig.* 2,

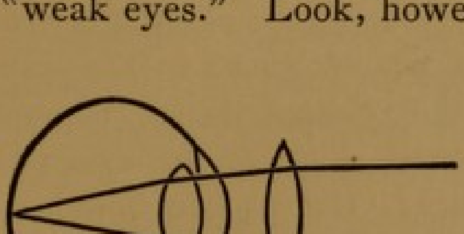


Fig. 2.

and you see that the convex glass, placed in front of the eye, converges the parallel rays somewhat, so that the eye can then focus them on its retina, without accommodation of the lens, which can be reserved to focus the diverging rays from near objects. This convex glass, therefore, is, as you see, an immense help to the over-sighted eye, rendering it, thereby, like a normal one, and relieving it from fatigue and overwork. You have learned, now, that it may be just as necessary for an over-sighted young person, perhaps even a child at six years of age, to wear convex glasses, as for a near-sighted person to wear concave glasses. From general ignorance and prejudice, the unfortunate children who are over-sighted are not allowed to wear spectacles, because these are found to be like "grandpa's." But you have learned that, although *old sight* and *over-sight* need convex glasses, they are not the same condition of the eye.

Another very important truth modern science has taught us is, that squinting, or turning the eyes inwards, is due, perhaps in ninety cases out of the hundred, to over-sightedness. Let us explain why. When we look at near objects we turn the eyes in, and, at the same time, accommodate the crystalline lenses. These two acts are intimately associated. The more we turn the eye in, the more we can accommodate. Now, if we turn the eyes too far in, we see things double. The over-sighted youth must accommodate strongly; he lets, therefore, one eye turn further in than the other; and, to avoid seeing double, *suppresses the image*, as it is called; that is, neglects to regard it, and perceives only with the other eye. But the moment this happens, the squinting eye *begins to lose its power of sight*, which may increase till it is quite blind. Test, for yourself, any child who has squinted a time, and you will be surprised to find how poor its sight is in the squinting eye. What can be done for this? Why, the oculist, by a slight operation, described in another article, can cut the muscle drawing the eye too far in, and then it turns with its fellow, and sight will wholly or partially return in it.

It is only comparatively recently that this hypermetropia, or over-sightedness, has been recognized as such a fertile source of impaired vision. Hundreds of people go on in life without using their eyes, because they think they cannot do so, when the whole trouble is simply due to the natural shape of the eye, which a proper convex glass remedies at once. Let us see how it was with the children Dr. Cohn examined in Breslau. Of the 10,060 children, 152 boys and 87 girls, *i.e.*, 239, were over-sighted, or hypermetropic. Very differently from myopia, no increase of hypermetropia was found with increase of age, or number of school terms. Only 9 children wore convex glasses, generally strong ones, by physicians' directions. 158 of the 239 hypermetropic children, squinted inwards.

Among the students examined, Dr. Cohn found only 15 hyperme tropic. He also found convergent squint in 64 children who were not hypermetropic, in 19 of whom it was complicated with other troubles, which may have produced it. But in 45 cases it was unassociated with any anatomical or refractive anomaly, and 35 of these children squinted periodically, the other 10 permanently. These facts especially excited Dr. Cohn's attention, and he sought the cause. The amount of squinting struck him at once upon entering the rooms of *certain* classes. In one of the elementary and one of the girls' high schools, there were quite a number of hypermetropic scholars, who squinted in consequence, and Dr. Cohn thought whether or not others, who squinted periodically, did not do so from imitation. This, as it seemed very doubtful, and is disbelieved by many competent observers, he was not disposed to admit till observation showed it to be true. In examining one of the girls' schools, he could find no explanation of the large number of scholars who squinted without cause; that is, who were not hypermetropic, etc. One of the teachers, however, he found squinted periodically, although her eyes were normal. She attributed the cause of it to a game, much in vogue in the school, which she herself had but lately ceased playing. Many of the children, every day, in the recesses, amused themselves by holding the forefinger at a distance and then bringing it up close to the nose, to within two inches, keeping the eyes fixed upon it. Then they removed the finger, and strove to see which one could longest keep the eyes turned in. Upon further examination, he found that those who squinted without cause had, in this manner, actually acquired the habit.

In 100 cases of convergent squint, Dr. Cohn found 71 hypermetropic, 8 with other affections, and but 21 without any trouble. Granting these latter to have perhaps acquired it from imitation, we have, out of 100 cases of squint, 71 dependent upon hypermetropia; thus confirming Prof. Donders's expressed views, who thinks probably 90 per cent. of the cases of convergent squint are due to hypermetropia. It is with the medium degrees of hypermetropia that squint becomes associated. But we know, as Dr. Cohn says, an eye which squints a long time gradually loses its power of seeing, because it does not exercise vision with the other; just as the left hand is generally weaker than the right, because it is less used. This is a long-known fact, that should induce every teacher to prevent the scholars squinting. Among 135 cases of permanent squint, the power of vision in the turned eye was reduced in varying degrees. We call V (vision) equal 1, when a type which a normal eye can read at 20 feet, can be deciphered at this distance. If it can only be read at 10 feet, then V is equal 10-20ths, or 1-2, etc. Correcting any near or over-sightedness with proper glasses, and then letting the eye, armed with these, read the type where it can, and we shall, if this distance is less than normal, and there is no disease of the several parts of the eye, have proof that the retina is less sensitive to impression, *which is exactly the case with squinting eyes.*

So surely as squinting is caused by hypermetropia, so surely is it alone cured in the first stage—periodic squint—by wearing convex glasses, which neutralize the over-sightedness. If, however, the squint has become permanent, the internal straight muscle of the eye that caused the convergence becomes shortened, and soon the antagonistic muscle, which turns the eye in the opposite direction, is weakened, and no longer able to perform its function. Hence an eye which has long turned in, finally cannot be turned out again. With permanent squint, the correcting glasses no longer avail. Only an operation can help the patient; namely, cutting the shortened muscle of the squinting eye, when it becomes attached further back on the globe, and acts, then, as if it had been lengthened. This operation is so perfectly safe, simple, and rapid of performance, that the earlier done the better, not only to remove the deformity of the squint, but to *improve the power of sight.* For as soon as the eye which has squinted resumes its motion with the other, it wholly, or in part, recovers its power of vision. "Of the 114 permanently-squinting eyes, *not one had been operated on.* And not one of the 44 periodically-squinting wore a convex glass. These eyes will, therefore, if nothing is done to prevent the squinting, assuredly lose a considerable power of vision."

The discoveries of Prof. Donders in reference to over-sightedness, have naturally caused ophthalmic surgeons, all over the world, to study the cases presented to them, and there is an universal agreement as to the effects of hypermetropia. As a distinguished London oculist, Dr. Wells, truthfully says: "Hypermetropia, or over-sightedness, is very frequently the cause of asthenopia, or *weak sight.* It is distinguished by the following symptoms: The patient cannot continue to regard near objects for any length of time, as in reading, writing, etc., without the eyes becoming fatigued. The print becomes confused and indistinct, the letters run into each other; there is a feeling of tension and pain about the eye and over the eyebrow, which, if the work is persisted in, soon becomes more intense, and sometimes even assumes the character of headache (which is often mistaken for nervous headache, or migraine); the eye, at the same time, becomes watery, red, and feels hot and uncomfortable. Yet there is nothing in the appearance of the eye to warrant this state of things. It looks perfectly normal, the refracting media are clear, vision is good, the convergence of the optic axes perfect, the mobility of the eye unimpaired. Neither does the ophthalmoscope reveal anything abnormal, except, perhaps, a slight state of congestion of the retina and choroid. And yet the eye is perfectly useless for continued work at near objects, for reading, writing, sewing, engraving, etc.; for symptoms of weak sight, or asthenopia, soon show themselves, and the work has to be laid aside. Then these symptoms quickly vanish, and the occupation can be resumed until their reappearance again necessitates an interval of rest; the longer this is, the longer will the person be able to recontinue his employment. All ophthalmic surgeons know from experience how wearisome such cases mostly prove in the treatment, and how unsatisfactory the result generally is after the whole routine of remedies has been gone through. Purgatives, sedatives, tonics, counter-irritants, alteratives — their name is legion! But yet how futile do they not almost always prove in curing this affection. But why do they prove futile? Because, in the great majority of cases, the asthenopia is not dependent upon any overwork of the eyes, or upon general debility, but upon *over-sightedness*, or also upon an *insufficiency* of the muscles which turn the eyeballs inwards. It was, indeed, a great boon when Donders discovered that most of these cases of asthenopia depended upon hypermetropia, and might, therefore, be permanently cured by the proper use of convex glasses. It has been thought that asthenopia might be cured by gradually accustoming the eye to weaker and weaker glasses, so as finally to render their use altogether superfluous. But the reader will now understand how just the contrary proceeding is necessary in hypermetropia. If we wish permanently to cure the patient, we must prevent all undue straining of his accommodation, and this can only be done by the proper use of convex glasses. Asthenopia is, in the great majority of cases, due to oversightedness; and those patients who, under any other course of treatment, haunt our out-patient rooms for months and years without relief, may be speedily and permanently cured by the proper treatment of their hypermetropia. Let us but consider the crowd of seamstresses, watchmakers, engravers, etc., who are rendered incapable of following their employment, whose future is starvation if this fact is not attended to."

Finally, we must here speak of another point in reference to over-sightedness, or hypermetropia, namely, that a hypermetrope, with good strong eyes, may get along, if this abnormal condition is not excessive, for many years without a glass, since, with good power of accommodation, he can adapt his eyes to see near objects. But we have learned that the power of accommodation fades from the tenth year of life; and probably at five-and-twenty years of age he will need to commence to wear glasses, which the normal eye would not be obliged to put on till at five-and-forty years.

ASTIGMATISM.

AGAIN, modern science has shown that there is another difficulty of the eye, giving rise to indistinct vision, which can be remedied by peculiar and properly-selected glasses. This is called astigmatism, and is caused by the clear part of the eye, the cornea, not having the same curve in all directions, so that the rays of light coming in a horizontal direction do not come to the same focus as those coming in a perpendicular direction. This difficulty is found quite frequent, there being many people to whom, for example, the upright portion of a cross is not as clear as the horizontal, or the reverse.

Fig. 3 represents such a test as we use to ascertain if the patient is astigmatic. If he sees all these spokes of the wheel, as it

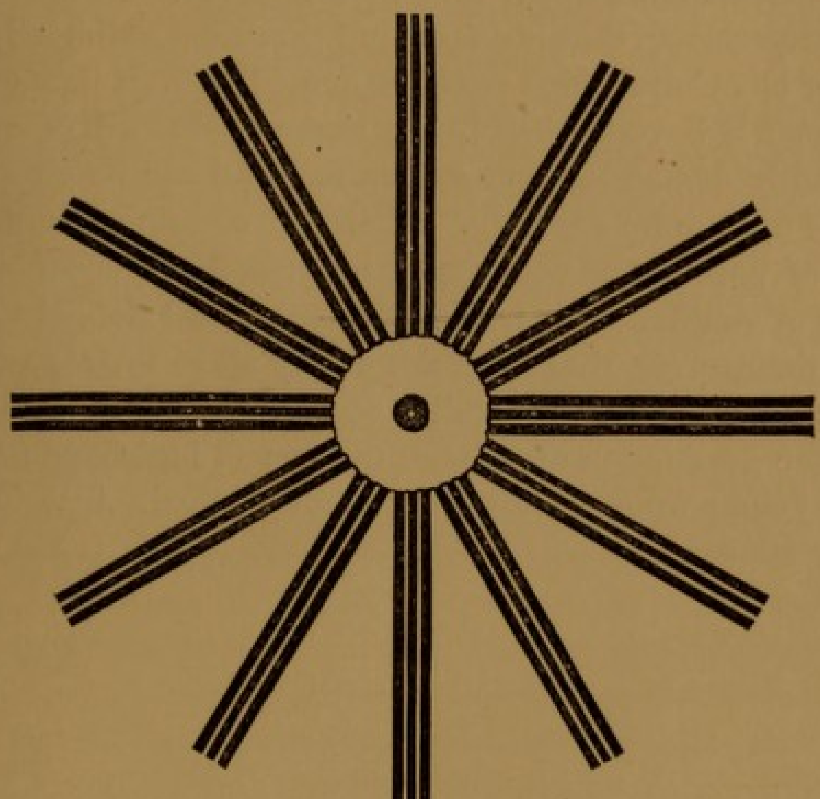


Fig. 3.

were, clearly and distinctly, and they all look alike, then there is no trouble. But if those in one meridian appear blurred, whilst those in the opposite are distinct, then there is astigmatism. This distortion of the picture is also readily, like myopia and hypermetropia, revealed by the ophthalmoscope. By it we see the entrance of the optic nerve inside of the eye appearing distorted, and not round, or nearly so, as it ordinarily does.

This impairment of vision can be remedied by glasses ground to meet the irregularity of the cornea; they are called cylindrical glasses; and it requires patience, knowledge, and care on the part of the oculist to prescribe them; but the improvement of sight amply repays the time given by both physician and patient. A distinguished physician, himself astigmatic, says: "Cylindrical glasses have completely changed my existence; before using them I was obliged to forego all work at night, but now I read, so to speak, indefinitely by the light of a single candle."

Amongst the children he examined, Dr. Cohn found twenty-three astigmatic, only *one* of whom was wearing cylindrical glasses, and he says: "The astigmatic patient, who, after long searching at the optician's, does not find any glass to suit him, is rejoiced to suddenly see everything clear and plainly through a cylindrical glass."

Finally, does all said in these two articles in reference to school-children and students apply to our community? We believe, from personal experience, that it does; and that such extended researches as those of Dr. Cohn which we have quoted from, if here undertaken, would prove it beyond doubt. A higher standard of education is being steadily demanded and striven for, and can be gained only by taxing the eyes more severely. It would certainly seem, therefore, the duty of parents, as well as all interested and occupied with the education of youth, our Boards of Education and School Committees, to assure themselves that they are doing all in their power to avert what the community generally recognizes as a growing evil; namely, the graduation of a large number of highly-educated young men and young women with permanently impaired vision, from unnecessary causes.

CATARACT IN CHILDREN SIMULATING NEAR-SIGHTEDNESS.

THAT we may be able, perhaps, by timely advice, to save useful vision for children born partially blind, we will endeavor to explain in untechnical language what *cataract* is, and how it may be readily mistaken, even by *physicians in general practice*, for near-sightedness. If the reader will study the previous chapters, he will be in better position to understand the anatomy and physiology of cataract; but in order to be clearly comprehended, we here give a section of the human eye:

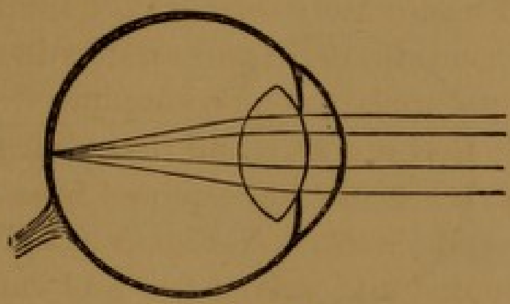


Fig. 1.

The optic nerve is seen entering the eyeball from behind; and through the transparent part of the eye in front, rays of light are coming, which pass through the pupil, and then, meeting the double convex lens called the crystalline, are further refracted to a focus on the retina, where a picture of the external object is painted exactly as in the *camera obscura*. Cataract is a partial or total opacity of this double convex lens. Many diseases of the eye produce *opacities* of the transparent front portion of the eye, and these are often ignorantly supposed to be cataract. Such opacities are also often produced by the quack eye-waters, which so frequently contain sugar of lead. Cataract, however, as is seen, is very different from opaque spots on the cornea. Rays of light only pass into the eye through the pupil, — the circular aperture in the iris. The lens is directly behind this aperture, the edge of the pupil touching it. Consequently, when the lens is opaque, the ray cannot pass through to reach the retina, or may be so broken up as to produce only a confused image not sufficient for good vision. The greater the opacity, of course the greater the blindness. When there is simply cloudiness of the crystalline lens, the patient will see indistinctly, as through smoked glass; but, when the lens is quite opaque, then he will only have perception of light as through ground glass.

Now cataract, as it occurs in children, is apt to affect the central portion of the crystalline lens, leaving the margin clear, through which the rays of light can pass to the retina, and there form a more or less distinct image of the external objects. From optical reasons, the image formed by rays of light thus passing through the outer portion of the lens is never so clear, and consequently vision never so good. In order that the rays of light may pass through the outer clear portion of the lens, the pupil must be somewhat dilated, as will be seen by the accompanying diagram (*Fig.* 2), where the central

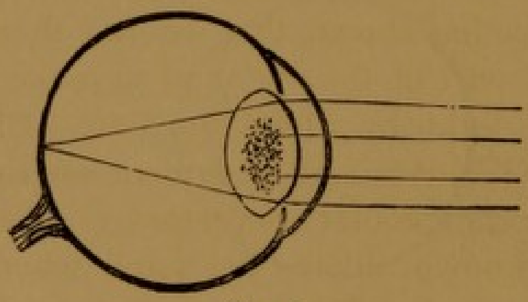


Fig. 2.

rays are stopped by the cataract, and only the outer ones can pass to converge on the retina, the pupil being dilated. It will be also seen that light may then get into the eye sideways, as it were, between the edge of the pupil and the opaque portion of the lens.

The stimulus of light contracts the pupil, as we all know; and therefore the little child with cataract, in order to keep the pupils large, seeks to avoid it by turning his back to the window, contracting his brow, and partly closing his eyelids; or, in other words, *imitating the appearance of a person who is near-sighted.* Moreover, in order to obtain larger pictures on his retina, or to get the light *sideways*, he holds the book close to his eyes, perfectly simulating what a near-sighted person without glasses must do. Meantime the opacity of the crystalline lens may be of such a character, or so far back in the lens, that the pupil to the unaided eye may seem quite black, as it naturally is; and thus even the family physician may be deceived into believing that the child is simply *near-sighted,* and consequently it is allowed to grow up without the ophthalmic surgeon being consulted. The latter can, by means of his ophthalmoscope, as the instrument is called, and by employing light thrown in sideways, immediately and perfectly detect the very slightest opacity of this crystalline lens.

This instrument, the ophthalmoscope, is a peculiarly arranged mirror, invented by Professor Helmholz of Heidelberg, in 1852, and its use has quite revolutionized the study and treatment of the internal diseases of the eye. Any one sufficiently familiar with it can examine the interior of the living eye, see the entrance of the optic nerve, the blood-vessels of the retina, and often count the pulsations of the heart in them.

Now, in order that light may pass to the retina, this partially or wholly opaque lens must be either removed from the eye, or broken up and allowed to dissolve; or, if only the central portion of it is opaque and the margin transparent, and this *state is to be stationary*, modern science has shown that we may then cut out a piece of the iris, or colored part of the eye, and so make an *artificial pupil* for the entrance of light, by which the little patient may be able to see very well. Experience and judgment on the part of the ophthalmic surgeon are, of course, necessary to determine this.

Atropine, as is known, dilates the pupil when put into the eye, and the travelling quacks often sell a solution of it to patients who happen to have cataract, both old and young. Its use will temporarily benefit them, as is seen by *Fig.* 2; for then the rays of light can get to the retina at the sides of the opacity of the crystalline lens, or where the opaque lens is thinner. The travelling quack soon has another name for his list of cures of cataract, without operation, heralded in the newspapers. The effect of the atropine passes off, however, in a few days, and the pupil returning to its normal size, the unfortunate patient is again as blind as ever. On search, then, for the advertising quack and his office, they will be found to have moved on to a new field in the next village, and the fee will be as hard to get back as it will be to remove the name and cure from the newspapers. We have seen enough of this to speak authoritatively.

The earlier cataracts in children are operated on, the greater the chance of restoring or retaining useful vision. The cataract itself generally continues to change, so as to render it less easily removed from the eye, or liable to complicate an operation. Another point, however, and one not generally understood, is, that when the retina ceases to be impressed by the stimulus of light and the formation of images upon it, the eye, — or, if we may so choose to say, the mind, — loses a proportionate power of vision. Further still, a retina deprived of its proper stimulus ceases, together with the optic nerve, to be properly or fully developed with the rest of the body. Consequently, even if we succeed in clearing the pupil and admitting light freely to the retina, the patient will not then have the power of vision, or the *appreciation of objects*, which they would have had if they had been operated on earlier. This the ophthalmic surgeon too often sees, and he may even be blamed for not having accomplished what would be a miracle. The operations for cataract in children are comparatively slight, and, in these days of ether, of course not in any way to be dreaded. Again we would repeat, the earlier they are done the better. The trustees of the Royal London Ophthalmic Hospital, at Moorfields, in London, in a late annual report, call the special attention of the public to the necessity of bringing children for operation at an early period, instead of allowing their eyes to be damaged by delay. The reports of the Eye Infirmaries in this country show that this is a still greater evil here, where distance from proper advice is, in many cases, such as to prevent parents carrying their children to those competent to give an opinion, or operate in the case. The ophthalmic surgeon only too often has led before him a young man or woman between twenty and twenty-five years of age, nearly blind from congenital cataract, whom an early operation would have saved, and enabled to have earned their living, which must now, for life, in whole or part, be supplied by friends, or the community.

We would therefore again call upon the readers of this article, parents and teachers, when they notice the little ones shunning the light, holding the book sideways or near to, and seeming dull in learning their lessons and letters, to remember that *cataract*, and not simply near-sightedness, may be the cause, although their eyes look perfectly natural to the observer. Patients with this form of cataract make out large objects at a moderate distance quite well, and usually read large type without hesitation (although not for a long while), especially when faulty adjustment of the dioptric apparatus is neutralized by suitable spectacles, and diffuse light avoided as much as possible, and when the pupil is enlarged, on account of slight illumination of the visual field. The disturbance of vision is particularly slight when the natural diffuse light is cut off, and the object is well illuminated. Hence patients shade the eyes as much as possible, and try to bring the object in a good light; they usually carry the head down, find dark glasses and broad eye-shades advantageous, and greatly prefer twilight and cloudy days. Whether there is *cataract*, or simply *near-sightedness*, can only be determined by the ophthalmic surgeon; and the sooner the child is brought to him, the better for its future sight.

CATARACT.

IN our article on "Cataract in Children simulating Near-sightedness," we have briefly explained what cataract is. We propose here to enter into a more detailed explanation of cataract in general; what it is, the causes of it, and its treatment by the ophthalmic surgeon. To do this, let us once more look at the section of the human eye.

Fig. 1.

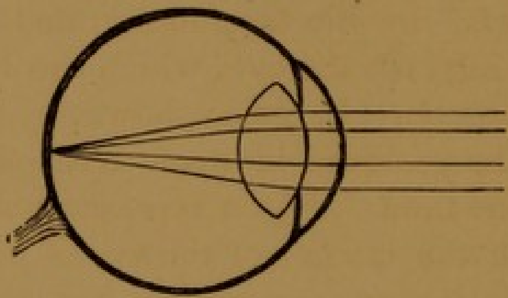
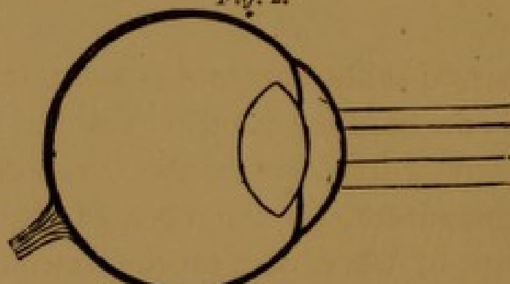


Fig. 1, the optic nerve is seen entering the eyeball from behind; and through the transparent part of the eye in front, rays of light are coming, which pass through the pupil, the round hole in the iris, or colored portion of the eye; here they meet the double convex lens called the crystalline, and are further refracted to a focus on the retina, where a picture of the external object is painted, exactly as in the *camera obscura*, or the photographer's apparatus. If the rays of light cannot reach the pupil, and so on to the retina, then the person cannot see with his eye.

Here again we want to be more explicit as to what cataract is *not*. On this point there is very great ignorance in the community, and there prevails among some in the profession a loose way of speaking of cataract. The eye and its humors are perfectly transparent through to the back part of the eyeball, where the retina is. The cornea, or clear part of the eye in front, like our watch-glasses, is one of the most transparent objects in nature. If it is dulled in any way the passage of the light is obstructed, and the patient proportionally blind. Now in *Fig.* 2, let us suppose the transparent

Fig. 2.

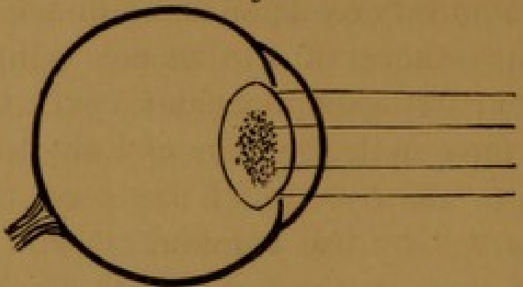


part of the eye has from any cause become opaque, and we see the rays of light are stopped by it, although the interior of the globe may have remained perfectly healthy, and thus the patient is blind. Now this clear part of the eye or cornea is quite thick and tough, and withstands injury more than would be imagined. It is, however, liable to ulceration and inflammation, both of which may leave permanent whitish spots or scars on it, thus rendering those portions of it so affected opaque. If such opacities cover the central portion, directly in front of the pupil, the rays of light cannot penetrate the eye for the patient to see by. Such spots on the cornea are frequently called "*pearls*" by the community, and supposed to be a "*sort of skin*" growing over the eye, which can be readily removed by the ophthalmic surgeon. In reality, however, they are scars, and can rarely, if ever, be removed or made transparent, especially if they have lasted some time. *Fig.* 2 represents such an eye, where we see that although the interior of the eye is perfect, the rays of light cannot penetrate the opaque cornea, just as we could not see the time on our watch if the watch-glass was opaque, or made of ground-glass.

Whenever the surface of the cornea is rough, or broken by injury, ulceration or inflammation, and a solution of sugar of lead is applied to the eye, there will result a deposit on and in the tissue of the cornea. In other words, we shall have a white film or flake of lead perfectly opaque. The consequence is that the unfortunate patient will be blind just in proportion to the size of this white spot or deposit, which *can rarely ever be removed* by the surgeon, as it is incorporated in the tissue of the cornea. The practical point is, that about all the so-called "eye-waters," sold under some quack doctor's name, contain this sugar of lead, which has blinded many an unfortunate person who has been advised by friends, or *the apothecary*, to purchase such nostrums. Acetate, or sugar of lead, is a weak astringent, and can be used with safety when there is slight conjunctivitis, or what is called a *cold in the eye*. There are, however, other much better mineral astringents, the use of which is unaccompanied by danger. It is not very safe for the patient or his friends to decide whether there is simply a cold, or further trouble requiring proper treatment.

We have now learned what cataract *is not*; let us, therefore, see what it is, and what can be done for it. You see in *Fig.* 1, behind the pupil, a double convex lens, called the crystalline. This must, as you also see, be transparent, for the rays of light to pass through it, and make a picture of the object on the retina in the back of the eye. When the lens is opaque, from whatever cause, it is called cataract, and the person having it is blind in proportion to the degree and extent of the opacity, since the rays of light are stopped from passing to the retina, as we see in *Fig.* 3. The

Fig. 3.



pupils of a person with cataract, instead of looking jet black, as natural, will appear whitish, or yellowish white, because we see the opacity of the lens, placed just behind the pupil, or hole in the iris. There is an alkaloid called *atropia*, made from the roots of the belladonna plant, or deadly nightshade, a solution of which, dropped into the eye, causes, without any pain or trouble, the pupil to dilate widely, so that the surgeon can then see almost all of the crystalline lens, and at once decide in reference to the cataract by throwing the light in side-ways, and also by means of a peculiar mirror, called the ophthalmoscope, which reveals the slightest trace of opacity of the lens. The reason people with cataract see better at twilight, and shade their eyes, or turn their back to the light or window, etc., is that the absence of the stimulus of light allows the pupil to dilate, and the light can then enter the pupil at the sides, where the lens is thinner, and where it generally becomes opaque last. When the surgeon puts atropine into a patient's eye who has cataract, they naturally see better, and say they "*have more light*." The quack, especially the travelling charlatan, takes advantage of this fact to cheat his dupes by. He, for instance, sees the pupil is colored instead of black, and knows enough to judge there is cataract. For a stipulated sum, *to be paid down*, he agrees to cure the cataract "without medicine or the knife," and warns the poor patient not to go near any eye hospital, or ophthalmic surgeon, for he will be sure to be operated on. The dupe submits, therefore, to paying the fee, and having atropine put in his eye, which dilates the pupil and gives more light, if not more sight. Of course there is no cure, as the cataract goes on increasing; and as soon as the application of the atropine is stopped, the pupil contracts again, leaving the patient even worse than before. The dupe now starts to hunt up the advertising oculist again, but finds he has vanished, and will, most probably, be found in the next town or village with the dupe's case in newspaper and handbills, placarded as a cure "*without medicine or knife*." This we have seen in all ranks and conditions in life, more often than it would seem possible for it to occur. The difficulty is just here. The daily newspapers, all of them, all over this country, make their money by advertising quack doctors and quack medicines. A large share of the money paid to and for these latter, goes into the newspaper proprietors' pockets.

The crystalline lens in the human eye is contained in a sort of envelope or capsule. The edge of the pupil, or rather the inner edge of the iris, lies against this capsule. Now, when the iris, as is very frequently the case, becomes inflamed, lymph is exuded from the iris on to the capsule of the lens in the pupil. This lymph becomes organized into a film or membrane, and as it of course stops the rays of light from entering the pupil, it was called, in old times, "spurious cataract." By *cataract* nowadays is always meant opacity of the crystalline lens itself.

What, now, are the causes of cataract? Some we know very well, but others are quite shrouded in obscurity. Injuries of the eye produce cataract. The lens will become opaque when a jar or shake, as from a railroad accident, or a blow on or near the eye, has caused the suspensory ligament of the lens to be broken so that it is detached. Any puncture of the lens, even the slightest, from needle, pin, glass, piece of steel, splinter of wood, fragment of percussion cap, broken spectacle frame, *et cetera*, any of these, or the many other foreign substances liable to enter the eyeball, may cause opacity of the lens, and thus what we call *traumatic cataract*, to distinguish it from that arising without direct cause.

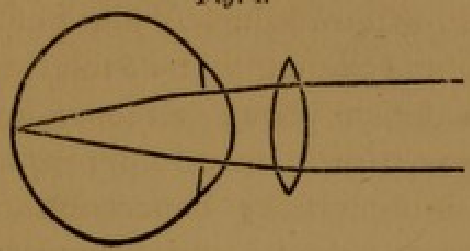
Cataract is liable to accompany some diseases. In diabetes, for instance, where the watery constituents of the blood are deficient, cataract will come on, generally, however, when the patient is broken down by the long continuance of the disease. In connection with this it may be stated that thick syrup injected under the dorsal skin of the frog, produces cataract in the animal, which is permanent. This is a fact which has been long known. It has also recently been shown that the consumption of bread containing ergot of rye, leads to the development of cataract. As a matter of course, all the various diseases affecting the inner coatings of the eye may finally lead to the formation of cataract by the nutrition of lens being interfered with. The deposits of lymph organizing into membranes in the pupil may lead to cataract in a similar way. As a general rule, however, cataract is a disease of old age, the lens becoming gradually opaque from deficient nutrition, and inadequate blood-supply causing diminution of the watery constituents of the lens. Cataract may also be congenital, as we have previously described in explaining how it may then be mistaken for near-sightedness. Cataracts may vary in color from a milky white to a jet black. When of this latter color, the pupil will of course look black, as naturally, and hence the person supposed not to be suffering from this disease. Sometimes cataracts, as in young persons, are perfectly soft, like jelly or sago; and sometimes, as in old people, as hard as wax or glue, or even containing chalky concretions. All these different conditions have to be understood and considered by the ophthalmic surgeon, when he has a case to operate on.

The symptoms of commencing cataract are a slowly increasing diffused mist, thin cloud, or gauze intervening before the eye and external objects. The cataractous person generally also sees better sideways than straightforward. As we have said, in twilight or partial daylight, the person will see better by the pupil's dilating more from the absence of the stimulus of light. A candle or street lamp seems expanded out into a larger flame. Objects like the moon, are often seen multiplied. This description will perhaps enable the laity to judge somewhat whether a person has cataract. The ophthalmic surgeon, by dilating the pupil with atropine, and examining with the ophthalmoscopic mirror, can, of course, decide the point instantaneously. Amaurosis, or absence of perceptive power in the retina, may cause a person to simulate a cataract patient. Moreover, a peculiar disease of the eye called glaucoma, may render the pupil quite of a greenish yellow color, and so imitate cataract, till the light from the surgeon's opthalmoscope shows that there is no opacity of the lens at all.

How, now, can we cure cataract? Here we want to be very clearly understood, as great ignorance prevails on this point in the community, continually kept up and fostered by the false advice of advertising quacks and travelling charlatans. When a cataract has once commenced to form, there is no medicine to be taken, or any local application made, which can in any way whatever affect it in the slightest. Relief can only be obtained by an operation, after the cataract is sufficiently formed, or "*ripe*," as it is called. Cataract operations are very delicate, and require knowledge, skill, and experience; hence they are rarely attempted by the quacks, who advise their applicants not to go where they will be operated on, and generally succeed in getting money out of them by ordering some patent medicine or other, *et cetera*.

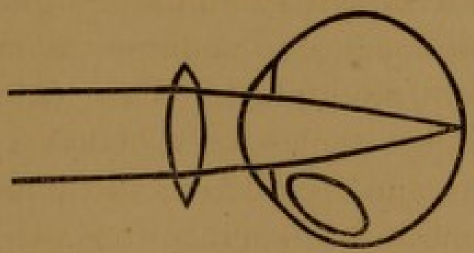
Three methods have been devised for operating on cataracts, all of which have in view the removal of the opaque lens or cataract from the pupil, so as to allow the rays of light to pass through to the retina, as we see in *Fig.* 4. The removal of the lens from

Fig. 4.



between the light and the retina, is a very old operation. Xenophon, in his Anabasis, so familiar to school-boys studying Greek, relates that Cyrus sent one of his generals to Egypt to be operated on for cataract by the ophthalmic surgeons there. This removal of the lens to a lower position, as is seen in *Fig.* 5, was done

Fig. 5.



by passing a needle in through the pupil and pressing it down, or passing in the needle behind the iris and turning the lens over. But we must only mention this operation to condemn it, as it is never practised nowadays, since the crystalline lens remains in the eye, and acts like a foreign substance, perhaps years afterwards setting up inflammation, and so destroying the sight. Another method was to prick the cataract with a needle, and by breaking it up let it absorb. This is still done with soft cataracts of children. It is of course a slow process, requiring to be repeated. No cataract in the adult should be thus operated on, as the centre of the lens is hard, and will not disappear without risk of dangerous inflammation.

The third method, now universally adopted, is the entire removal of the opaque lens from the eye. This seemingly bold operation was first done by a French physician named Daviel, in 1740. Of course, since then, very great improvements have been made in the various steps of the operation, as well as in the treatment before and after. Modern surgery now loses but three per cent. of the eyes operated on, instead of fifty per cent., as was done one hundred years ago. The precise method now being universally adopted, is that of the late lamented Prof. Græfe, of Berlin, who stood at the head of ophthalmic surgery. It is the following: A narrow delicate knife is passed through the sclerotic so as to transfix the eyeball in front of the iris, and made to cut its way out, leaving a wound large enough for the cataract to come through. A piece of the iris is removed with delicate forceps, and the capsule of the lens punctured so as to allow the cataract to escape through the wound, which is accomplished by delicate pressure with an appropriate instrument. The eyes are then both most carefully bandaged, to prevent movement of the eyeballs, and the patient kept in the recumbent position from three to six or eight days. We have dismissed him within a week, but generally two weeks or more is required before the patient can travel to return home, if he live at a distance. By that time the eyes can be tested for cataract glasses, and of these they will need one pair for looking at distant objects, or to go about with, and another pair to read or sew with. *Fig.* 4 explains why the patient requires a glass. It will be seen that the double convex lens within the eye, which, when opaque, constitutes the cataract, has been removed, and consequently we must replace it by another in front of the eye, namely, the spectacle-glass. Here again we want to be explicit, as much ignorance prevails as to the power of sight cataract patients ought to have after operation. This does not depend so much on the operator, skilful as he must be, as it does on the cataract itself, *i. e.*, whether it was produced naturally, so to speak, by old age, or was the result of some disease of the eye, since in the latter case sight will not be so much improved after the opaque lens has been removed from the pupil. In these days of ether and chloroform, one or the other is always administered, so that the patient suffers no pain, and after the operation is often unable to say which eye was operated on. Their joy at restored vision, and their thanks for sight, are the reward of the ophthalmic surgeon who has persuaded them to submit to, and has successfully carried out, a cataract operation.

ARTIFICIAL EYES — How and why they are worn.

THE wearing of some artificial device to conceal the loss of the visual organ, seems to date back at least to the time Egypt was a flourishing country, centuries before the Christian era. The manufacture of artificial eyes has always been a trade by itself. The various precious metals were used in their construction, such as gold and silver, and afterwards copper and ivory. Patriotic citizens have carried them to the public treasury as an offering in time of war or general distress. In Europe they were naturally somewhat of a rarity, till the invention of porcelain eyes in the sixteenth century. We quote the following from Ambrose Parey, in the translalator's quaint old English of 1665. He says: "Therefore if that through any mischance, as by any inflammation, any man's eie happen to be broken or put out, and the humors spilt or wasted; or if it be strucken out of his place or cavity wherein it was naturally placed, by any violent stroke; or if it waste or consume by reason of a consumption of the proper substance, then there is no hope to restore the sight or function of the eie, yet you may cover the deformity of the eie so lost (which is all you can do in such a case) by this means: If that when you have perfectly cured and healed the ulcer, you may put another eie artificially made of gold or silver, counterfieted and enamelled, so that it may seem to have the brightness or gemmy decency of the natural eie, into the place of the eie that is so lost."

Here follows a rough wood-cut of such enamelled eyes, in shape not unlike those now worn. The great surgeon of his day then goes on to say:

"But if the patient be unwilling, or by reason of some other means, cannot wear this eie so prepared, in his head; you may make another in this wise. You must first have a string or wier of iron, bowed or crooked, like unto womens' ear-wiers, made to bind the head harder or looser, as it pleaseth the patient, from the lower part of the head behind, above the ear, unto the greater corner of the eie; this rod or wier must be covered in the silk; and it also must be somewhat broad at both ends, lest that the sharpness thereof should pierce or prick any part that it cometh unto. But that end wherewith the empty hollowness must be covered, ought to be broader than the other, and covered with a thin piece of leather, that thereon the colors of the eie that is lost, may be shadowed or conterfieted. Here followeth the figure or portraiture of such a string or wire."

Nowadays an artificial eye is made of glass or enamel, and is a little thin light shell formed to represent the front of the eyeball. Their manufacture, although a separate trade, is quite simple. The part imitating the sclerotic, or white of the eye, is made of white enamel, with a tinge of yellow. The posterior lamina of the central piece is colored and streaked, to look like the iris, or colored part of the eye. On the middle of this lamina a circular patch of black enamel is laid, to imitate the pupil, and the superficial lamina is transparent glass. Threads of red enamel are spread over the surface in imitation of blood-vessels, and are melted in before the blow-pipe. A great variety of colors and shades are made, and considerable difference in the shape and size, so that from a large collection almost any eye can be imitated, though of course it is much better to have the eye made to exactly match the other sound eye, and this is the method most frequently followed.

The instructions given to persons wearing an artificial eye, are:

It should be taken out every night, wiped and washed, and replaced in the morning.

To put the eye in. Place the left hand flat upon the forehead, with the fingers downwards, and with the two middle fingers raise the upper eyelid towards the eyebrow; then, with the right hand, push the upper edge of the artificial eye beneath the upper eyelid, which may be allowed to drop upon the eye. The eye must now be supported with the middle fingers of the left hand, whilst the lower eyelid is raised over its lower edge with the right hand.

To take the eye out. The lower eyelid must be drawn downwards with the middle finger of the left hand, and then with the right hand the end of a small bodkin must be put beneath the lower edge of the artificial eye, which must be raised gently forward over the lower eyelid, when it will readily drop out; at this time care must be taken that the eye does not fall on the ground, or other hard place, as it is very brittle, and might easily be broken by a fall. In order to avoid this accident, the patient should stoop over a cushion or handkerchief placed on a table, or over a bed.

The best made artificial eyes will not wear longer than a year, as the enamel becomes rough, and a source of irritation to the lids and socket. A spare one should be kept on hand in case the one being worn is broken, or cracks, as it may do from sudden variation of temperature. There is, or should be, no pain from the insertion, removal, or wearing an artificial eye. It is amusing to see the charlatans taking advantage of popular ignorance, by advertising to *insert artificial eyes without pain.* The dentists might as well advertise to insert false teeth without pain. With what degree of comfort an artificial eye may be worn, depends entirely on the individual case. When the eyeball has been properly removed for any cause, then a glass eye can be best worn. It is curious to read the advertisements of the manufacturers of artificial eyes. One would almost believe it was, on the whole, better to wear glass eyes than have natural ones. It is a misfortune to be obliged to wear a false eye, for it is a source of constant expense, and of frequent mortification and anoyance. Fortunately modern science has, by modifying the necessary operation, and by the perfection of the imitation itself, done much towards mitigating this so frequent deformity. When the eyeball from injury or disease has shrunk to a small size, the eyelids lose their support and elasticity, and soon become motionless, and sink into the orbit; consequently the edges of the lids, with the lashes, turn inwards towards the remains of the globe, and irritate it. The space between the lids and the globe also becomes contracted, and the tears and mucus gather behind the lids, because the eyeball no longer pushes them forward and out, or towards the nose, to pass down the tear-passages into the nasal cavity. In these cases an artificial eye, when worn, will take the place of the diminished eyeball and restore the proper functions, so that the patient will be much more comfortable. Whether an artificial eye can be worn must be decided by the case itself; that is, it is dependent on the state of the globe and lids, for injury and disease leave these in very different conditions. The more shrunken and smaller the globe, the better chance for a false eye. If there are fleshy attachments betwen the lids and eyeball, they will probably have to be removed or overcome; but this is one of the most difficult things the ophthalmic surgeon has to do, for no matter how thoroughly these bridles are separated, they grow again, and are very troublesome, frequently absolutely preventing an eye being worn. If the eyeball is larger than natural, or has any protuberances or projections on it, an artificial eye cannot be worn. In general terms, if any part of the front half of the original eyeball remains, it will interfere with, or prevent an eye being worn. The slightest pain on pressure over the remains of an eyeball is a positive contra-indication to wearing a false eye. Such an irritable stump should be removed, and then the patient can wear a glass eye with ease.

Whenever an eye has been lost by injury or disease, any portion of the eyeball remaining may, perhaps twenty years afterwards, produce pain and trouble in the remaining sound eye. This is now an established fact. A patient with an injured or inflamed eye will have, in the other sound one, intolerance of light, sensation of fulness, even perhaps perceptible to the touch, inability to use the eyes, and fatigue, long before he may apply to the ophthalmic surgeon, who at once recognizes this insidious sympathetic irritation from the other eye, as we call it. Now the best and only means of allaying this sympathetic inflammation, is to at once remove the remains of the injured eyeball. But we frequently have to remove an eye even while there is sight in it, to prevent its affecting the other; for instance, when a foreign substance, like a piece of iron, has gone into the eyeball. The removal of the eyeball is called *enucleation;* and that the community may better understand the necessity, simplicity and effectiveness of this so valuable operation, is one of the purposes of this article. Also that they may be taught to no longer dread it as something terrible, to be avoided to the last. Enucleation may be needed simply to get rid of an enlarged eyeball, which the lids will not cover; it having become a deformity, which we remove to give place to a false eye. A high authority says very clearly and distinctly, the facility with which enucleation is performed, its great freedom from risk, and the adaptability of an artificial eye, ought to make us consider a disorganized eye, which is the seat of pain or annoyance, as a foreign body, whose removal the sooner it is accomplished the better. If not painful at the time, it is a deformity, and is liable at any time of ill-health to become the seat of inflammation, and affect sympathetically the opposite organ. It is not only unwise, but incorrect, to bring before the patient's imagination the idea of "taking the eye out," and omitting the scientific advantage of enucleation. Still another high authority says in these words: "Whenever I am satisfied that an injured globe is utterly lost, I always advise its removal without loss of time. By adopting this course, the patient's suffering, often extreme, is at once put an end to, and I think, also, the risk of sympathetic inflammation of the other eye is avoided."

In truth, the more this operation has been used by surgeons at the great centres of ophthalmic practice and clinical study and teaching, the more strongly do they speak of its value, simplicity, and necessity. Now, I constantly find among the community a perhaps natural horror in reference to removal of the eyeball, no matter how useless this organ may have become as respects sight, and when it has been the seat of severe or lasting pain; and I have even found medical gentlemen, when bringing their patients to the specialist, shrinking from advising them to submit to the removal of a sightless globe. There seems to be a sort of vague sensation among the community, and perhaps even among physicians, that enucleation of the eyeball is a formidable and dangerous operation, only to be resorted to in malignant disease, or as a last resort. People in general do not distinguish between the comparatively trifling operation of enucleation of the globe, and the, at present, rarely necessary and more formidable one of evacuation of the contents of the orbit. I will, therefore, as simply and in as untechnical language as possible, explain the anatomy of the operation, as I have shown its necessity and application.

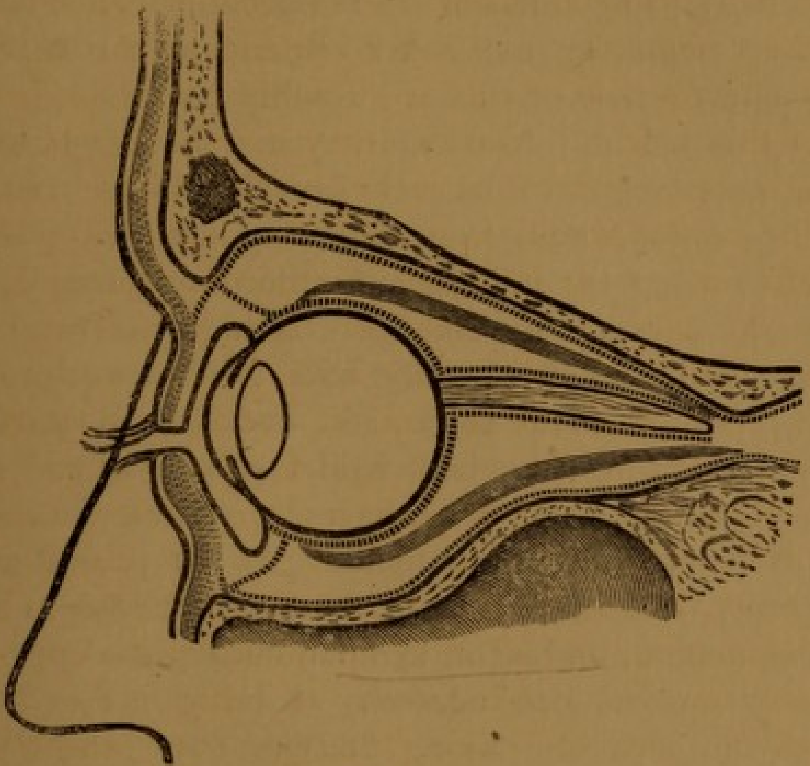


Fig. I.

Fig. I is a diagram of a vertical section through the orbit and eyeball. The thick dotted line represents a sort of strong fibrous capsule which, as is seen, lines the orbit and passes around the eyeball itself. The tendons of the muscles which move the eyeball pass through this cup-like membrane, as is seen above and below in the diagram. For the surgical purposes of this operation of enucleation, as it is called, it may be regarded as a membranous sac in which the globe rolls, and which is pierced by the tendons of the six muscles moving the eyeball. Now, then, if we simply cut these tendons in front of the capsule at their insertion into the globe, and the optic nerve behind, which goes from the eyeball to the brain, then the useless or painful globe can be removed, and we leave this membranous sac as a basis or support for an artificial eye, and the muscles being still attached to this capsule will therefore move it, and the glass eye lying on it, in nearly as great a degree as the muscles will move the natural eyeball. I will here at once answer the question which may arise, by saying the false eye will move nearly, if not quite as well, and sometimes even better, bedded on this membranous capsule, than if resting on a stump of a lost eye. I may say, I have seen the muscles move the glass eye sufficiently to deceive, at first glance, even an ophthalmic surgeon, as to whether the eye was false or not. But the point is just here, and it must be kept steadily in mind: The artificial eye will move well enough on the capsule, except in rare cases, therefore the remains of an injured eye had better always be removed before a false eye is worn, because it may be irritated by it, and give rise to this dangerous sympathetic irritation I have described above.

It is only within the last twenty years that this operation of enucleation, now found so frequently necessary, has been generally practised. In former times, the necessity for the removal of an injured eye to avoid its affecting its fellow, was felt, but the operation for such removal included the evacuation of the contents of the orbit, muscles, membranes, and all. Moreover, the removal of a portion of the offending globe, still occasionally practised, was not found to be equally beneficial, whilst the patient was frequently, if not always, a long time in recovering; on the other hand, after simple enucleation the entire offending organ is disposed of, and the patient has no further trouble than the operation, being able very shortly, within a fortnight, to wear an artificial eye. I do not in any way pretend that the necessity of carrying a false eye in the socket is a trifling circumstance. It is an expense, and a constant source of annoyance and chagrin; but on the other side is the certainty of losing the other sound eye by that insidious sympathetic inflammation so dreaded by the ophthalmic surgeon for his patient. The expense and annoyance, also, of a false eye, is not to be compared with the deformity of an enlarged and discolored eyeball, which, when removed to give place to an artificial eye, renders the bearer able to obtain and pursue employments from which they are otherwise quite cut off. When an artificial eye can be worn, it is generally better than the wearing a patch, or dark spectacles with side-pieces. Where original injury, or the old operations, have not interfered with the eyeball and its surroundings too much, an enucleation, when practised, gives more and better room for a glass eye, and, as I repeat, less danger to the other eye.

Persons who have lost an eye, even if they wear an artificial one, frequently have a peculiar look on that side of the face, which has a different outline and feature compared with the other. They appear thinner, or not in good health, to which the bright cheeks and lips give the denial. This is due to the fat, which is in the orbit, and on which the eyeball rests, becoming absorbed, and allowing the membranous cup and false eye with it to sink deeper. This, of course, is quite unavoidable.

I have thus shown how frequently, and why, ophthalmic surgeons are forced to remove the eyeball, and hence how often we may meet with those obliged to wear false eyes to conceal the deformity. But I trust I have also shown my readers the simplicity of the present operation of enucleation, and in part, at least, removed their natural horror of losing even a blind and offending organ, perhaps frequently painful, and always a constant source of danger to the other sound eye.

SQUINTING EYES:

Why and How they must be Operated on.

IN order to understand how and why an eye squints, as it is called, that is, turns in or out away from the direction in which its fellow eye is looking, we must have a clear idea of the muscles which move the eyeball, and see just how they effect this motion. The human eye has six muscles attached to it. Four of these are called the straight muscles, because they run straight backwards from the globe to the back part of the orbit, where they are attached to the bone. The other two are called the oblique muscles, because they run obliquely, as it were, to the eye. The straight muscles are attached above, below, to the inner and to the outer side of the eyeball. The upper oblique muscle is attached to the outer and back part of the eyeball, and the lower oblique to the outer and lower part of the globe. These muscles and their attachments are readily seen in the accompanying figure. We have the right eyeball with the cornea A

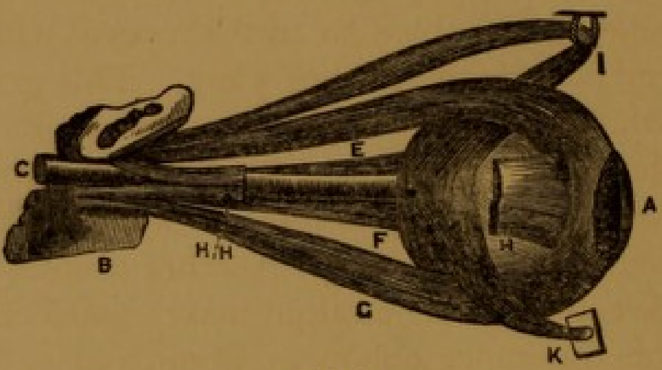


Fig. 1.

in front, and the optic nerve running from it to C, where it is cut off. E, F, and G, are respectively the upper, inner, and lower straight muscles. H H is the outer straight muscle, cut off at H, to exhibit the inner one. I is the superior oblique muscle, where it runs through a sort of pulley on the inner and upper part of the orbit. K is the attachment of the lower oblique muscle at the inner and lower corner of the orbital edge. B is the bony apex of the orbit, where all but the lower oblique are attached, since the upper oblique, as is seen, runs through the pulley backwards, to be fastened to the bone near the others. All this will be still more apparent by reference to *Fig.* 2, further on in this article.

Now, in general terms, the four straight muscles move the eyeball in the direction indicated by their names, i.e. upwards, downwards, inwards, and outwards, arranged in corresponding pairs;

therefore, whilst one is contracting the opposite one must relax. The two oblique muscles, also, form an antagonistic pair, and their effect is to rotate the eyeball around its axis, or a line drawn from the centre of the cornea, or front of the eye, through the centre of the globe, to the back of the eyeball. The upper oblique, also, turns the cornea downwards and outwards, and the lower oblique up and outwards. The reason the muscles, when contracting, do not move the eyeball from its position in the socket, but simply rotate it, is, that, as is seen in *Figs.* 1 and 2, the points of insertion of the muscles in the eyeball are in front of the transverse diameter, curving over the convexity of the eye. When in action, each muscle's effect must therefore be to turn or rotate the globe, so that the cornea will be directed either upwards or downwards, outwards or inwards, as the name severally indicates. If any two adjoining straight muscles act together, the cornea will be turned to a point intermediate between those to which they would direct it if they acted separately. Thus the upper and outer straight muscles acting together, turn the cornea upwards and outwards; the lower and inner muscles turn the cornea downwards and inwards. By this succession and combination of action, the muscles are enabled to turn the eye, with the minutest precision, to every point in the field of view. This general idea, although not the whole or exact effect of the muscles of the eye when in action, is sufficient for our present purpose. A single nerve coming from the brain, directs the action of the upper, lower, and inner straight, and lower oblique muscles. Another distinct nerve coming from the brain, directs the outer straight muscle, and still a third from the brain, governs the upper oblique. Compared to the work to be done, namely, simply the rolling of the eyeball round its centre, these muscles are very large and strong, and seemingly more numerous than need be, since four could effect the same motions. It must be remembered, however, that except during sleep, the eyeball hardly ceases motion for an instant. The arm, although largely supplied by strong muscles, could not be kept in such constant motion without fatigue, whereas we never notice any effort in turning the eyes, what is called fatigue of the eyes coming from a very different source, namely, continued muscular effort within the eyeball to accommodate our sight for the work employed at the time.

But we have two eyes, and to see objects singly and clearly, we must keep both the optic axes pointed to meet at the object looked at. Therefore, if we look to the left, the *outer* straight muscle turns the *left* eye in that direction, whilst the *inner* straight muscle turns the *right* eye towards the same point. Moreover, when the optic axes are correctly pointed to meet at the object looked at, the eyeballs must also have the same degree of rotation around their optic axes. This is more readily understood if we imagine a vertical plane passing through the two optic axes, like meridians. These two meridians, or vertical planes, must always be kept parallel, to insure our seeing things singly. If they are not parallel, we see things instantly double; a pen-handle held before the eyes will appear to have another one at its side, inclined towards the first. By shutting each eye alternately, we find to which eye each image belongs. Now this constant parallelism of the vertical meridians is kept up by the action of the oblique muscles, assisting and correcting the action of the others. The necessity for the large number and peculiar character of the ocular muscles is thus rendered more comprehensible.

For each and every position of an object in front of us, or, in other words, for each and every direction of the optic axes, there is, of course, a corresponding definite action of each ocular muscle. Any excess of action or want of action of a single muscle, or of several muscles, produces double sight at that point of our field of vision, to turn the eye towards which these muscles are called into play. Hence the reverse holds true, namely, if in any part of the field of vision an object appears double, and these two images have certain inclinations towards each other, we can decide that certain muscles are paralyzed, or fail to do their work, or their opponents act too strongly. It is, in fact, by the peculiar position and relations of double images when seen, that ophthalmic surgeons decide what muscles are affected, and how and when to operate, in order to remedy the evil by restoring the mutual action of the two eyes, and thus give the patient single vision again.

Now squinting, as I said, was the inability to direct or converge the two optic axes on the object; whilst one is pointed at it, the other is turned in or out beyond it, according as there is converging or diverging squint. But persons who squint continually, rarely see objects double. Double vision is such an annoyance, and source of danger even, that a person affected by it is always anxious for its immediate relief. How do squinting people get rid of it? Why, by simply seeing with the one eye, or mentally suppressing one image, as it is called. A watch-maker, engraver, or wood-cutter, working with a single magnifying glass, does not need to shut the other eye. He simply suppresses the image, or disregards it, although, of course, it is present on the retina. The same with the use of the telescope, microscope, or ophthalmoscope. It is a power readily learned, and should always be employed, since it avoids the muscular effort and consequent fatigue from keeping one eye closed. Any one trying, will be surprised how soon they can acquire this power of suppressing one retinal image, whilst we regard or take cognizance of the other alone, as the person affected with squint must of course do, or he would otherwise see double. There is, however, this difference between a person who squints, and another using but a single eye at a time; namely, that the squinting person *constantly* suppresses one retinal image, or, in other words, fails to use the eye which turns in or out to see with, the other alone being employed. Here, then, we have finally arrived at the practical point of this article. Whenever an eye turns in or out, away from its fellow, and the retinal image is consequently suppressed, *the power of sight begins to fail in the eye, and goes on decreasing till it is almost blind, or can only distinguish large objects.* The other eye may remain perfectly good, but of course all the work is thrown upon it. The absolute necessity, therefore, of remedying squint, is at once apparent. Children who squint should be operated on whilst young; I mean at four or five years of age, for thus only can we make the eyes do their work together, and prevent the loss of sight sure to follow. Moreover, if there has been some loss of vision in the squinting eye, it will return in whole or in part, when it is again brought to act with its fellow. This is a fact only known and understood in quite recent times — I mean the last few years. It was a powerful cause to throw discredit on the operation for squint in adults, since the patients did not, at any rate at first, see any better after than before operation, or, what often occurred, the patient did not know that he could not see well with his squinting eye, and first tried it alone, perhaps, after the operation for squint had been performed, naturally, therefore, accusing the operator of having partially destroyed his sight in that eye. From what I have now said, the whole truth can readily be understood by any one, and need be only told to be comprehended perfectly.

Now as to the causes of squint. There is much credulity and ignorance on this subject in the community, and I desire, therefore, to be clear and explicit in my description of the causes of squint, which, we shall see, are quite different from those generally supposed. When an eye, from paralysis of several of its muscles, is fixed in any given direction, and cannot move with the other, it was formerly also said to squint; but nowadays, by squint, of course we mean an inability to bring both visual lines or axes to bear simultaneously upon one point, the one always deviating in a certain direction from the object. The community generally, and often physicians also, are apt to attribute squinting to all sorts of causes, frequently, in fact, to anything which is sufficiently prominent in the child's life to have especially attracted the attention of the parents or attendants. Diseases and injuries of the brain may sometimes produce squint. Squinting may be acquired by a child imitating another whose eyes are turned. A trick of looking at the nose may produce it, as also many repeated attempts to see how near an object can be brought to the face and still be seen, played as a "game" in some schools. Paralysis of any ocular muscle, from injury or disease, may cause squinting. An opaque spot on the cornea may induce the eye to turn in or out, in order to allow the light to pass by it to the pupil.

The two most frequent forms of squinting, namely, simply *converging* and *diverging*, are due to very different causes than the above. Probably eighty per cent. of all cases of converging squint are caused by over-sightedness, or *hypermetropia*, as it is technically called. What this is, I have previously explained, but I will repeat here that it arises from the eyeball being too short from before backwards, so that rays of light cannot be properly focused on the retina without an excessive strain on the muscular power in the eye, which enables us to adjust it for near objects. It is relieved by a convex glass placed before the eye. A child even at seven to ten years of age, who is over-sighted, may require the spectacles which his father, or perhaps grandfather, uses. When we look at near objects we converge the eyes, of course, and with this act is intimately associated this power of adjustment. The more we turn the eyes in, the more we can adjust them for near objects, or accommodate, as it is called. The over-sighted person must accommodate strongly; therefore he lets one eye turn in further than the other, i. e., he squints. This would make him see double, and to obviate that, he *suppresses the image* in the squinting eye, as I have already described. The moment this happens, the squinting eye begins to lose its power of sight, which, as I have said, may increase to almost total blindness. Squinting from over-sightedness may be cured in its first stage by wearing appropriate convex glasses, which neutralize the over-sightedness. When the squint has become permanent, the inner straight muscle of the eyeball becomes shortened, and its opposite one weakened, so that it can no longer pull the eye outwards. In this condition nothing can be of avail but the operation for squinting, shortly to be described.

Just as over-sightedness, or *hypermetropia*, causes *convergent* squint, so near-sightedness, or *myopia*, when excessive, produces divergent squint. In near-sightedness the eyeball is too long, and, on account of its ellipsoid, or egg shape, its range of movement is limited, especially inwards. A very near-sighted eye must, however, have the object very close, and, of course, turn the eyes proportionately inwards. This causes exertion and fatigue, to relieve which one eye is allowed to deviate outwards, whilst the other turns inwards. Here, too, the person will have double images, and gets rid of that annoyance by, as in the converging squint, mentally suppressing the image of the squinting eye, which soon also begins to lose its power of sight, till almost blindness ensues.

All these facts are the result of recent investigation. The operation for squint was first done to remove the deformity, and all squinting eyes were indiscriminately operated on. Naturally the results were often quite unfavorable, so much so that the operation gradually fell into great disrepute, and began to be neglected. The operation is not generally of itself a very difficult one, but there are many cases which require great care, exactness, and expertness in the previous examination of the eyes, the investigation of the character of the squint and its amenability to treatment, as also in the precise mode of operating. These are some of the most difficult problems the ophthalmic surgeon has to solve. The present operation for squint, means the bringing back the two eyes to see together and move in consort; quite a different thing, and more difficult task, than the former idea of simply removing a deformity.

It is only about thirty years ago that the operation for squint was first successfully performed. It is not now, as then, always practised, since there are some methods of relieving slight forms of squint without operation. These I cannot here enter into, as they would not be readily understood, except by those familiar with the whole subject. We owe it to the late lamented Prof. Græfe, of Berlin, to have rescued the valuable operation for squint from being neglected or entirely thrown aside, and this not by any special perfection in the carrying out of the operation, but by the scientific study of the optical condition of the eyes, and the causes leading to their unequal convergence or divergence. But it requires years of special study to enable the ophthalmic surgeon to acquaint himself with these investigations, so that he can apply the laws deduced in any given case, and thus successfully examine and operate on a squinting eye. The general surgeons do not of course follow such special studies, and it cannot be expected of them so to do; hence their lack of success with the squint operations, which they finally almost ceased to perform.

It remains for me, finally, to describe the operation itself, which may readily be understood with a little attention to what here follows.

First we must have still a little better idea of the anatomy of the parts concerned.

In *Fig.* 2 we have, of the natural size, a horizontal section just

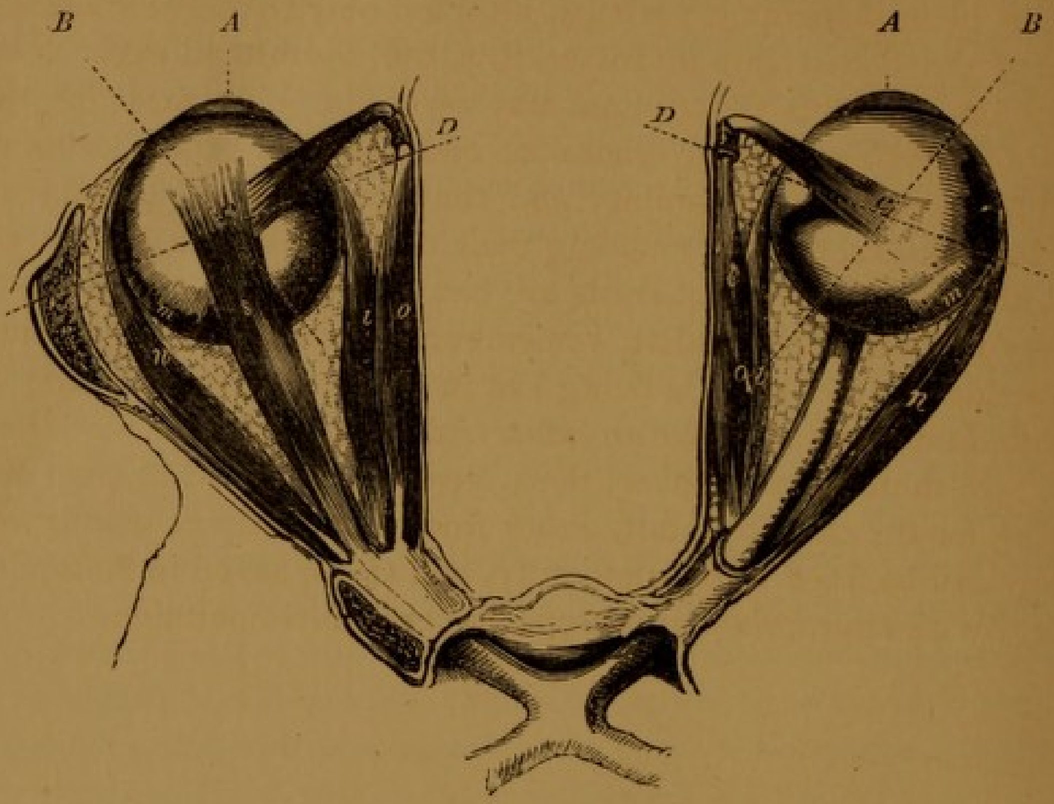


Fig. 2.

above the eyeballs, which we see with the optic nerves going from them to pass inside the skull, where they join and intermingle. The space between D D is the cavity of the nose; A A are the lines of the optic axes; n n are the two outer straight muscles; i i the two inner straight muscles; o o are the two upper oblique muscles. The two lower oblique muscles of course cannot be seen from this point of view, which is from above; we see, however, where they are attached to the globes at m and m. In the left eye, s is the upper straight muscle, which, in the right eye, has been removed to show the optic nerve. c c, where the two dotted lines cross, are the centres of motion of the globe. The dotted lines B B are the axes around which the oblique muscles move the globe. The dotted lines D D are the axes around which the upper and lower straight muscles move the globe. The axis of motion of the outer and inner straight muscles is a vertical line through the point c. In the right eye, the outer portion, or wall of the orbit, is removed. The operation for convergent squint, is to cut the tendon of the inner straight muscle where it is attached to the eyeball, just where the dotted line D crosses it in the figure. The muscle then draws back and attaches itself again to the globe, whilst the eye turns out to correspond to the other. When the eyeball turns out, or divergent squint, then the operation is to cut the inner muscle as before, bring the end forwards and attach it to the globe — cutting, perhaps, also the outer straight muscle just where the dotted line D crosses it in the right-hand eye. I trust, therefore, that this description may serve, in some measure, to remove the wide-extended ignorance and credulity of the community as to the operation for squint; and that quacks and charlatans will no longer succeed in persuading their clients that the eye is taken out and replaced, or that cords are cut, and all such nonsense. Let every parent and guardian remember that a squinting eye means something — that sight is being lost in it; and that the sooner some ophthalmic surgeon — *not an advertising one* — examines it, the better. In these days of ether, there need be no dread of pain or suffering for the child or adult, either from the operation or afterwards. They can be freed from a deformity, and vision saved in the squinting eye, by an appropriate and properly-performed operation.

AN ARTIFICIAL PUPIL—WHAT IT IS:

How and Why the Operation is Performed.

PROBABLY most of my readers have heard of an artificial pupil, as they have heard of an artificial eye; or they have some friend whose eye has a slightly unnatural appearance from having an artificial pupil. An artificial eye is a little shell of glass, imitating the natural eye, and inserted between the lids to conceal the loss of the visual organ. An artificial pupil is quite a different affair. It is an additional pupil made through the iris. Here, as always, we must understand a little anatomy, in order to comprehend our subject, and for this purpose we may use a friend's eye to look at, or our own in a mirror. The colored part of the eye is called the iris. The black round spot in the centre of it is the pupil; which is simply a hole through the iris, as is seen in this little diagram of a section of the human eye (*Fig.* 1). No rays of light can pass into the eye

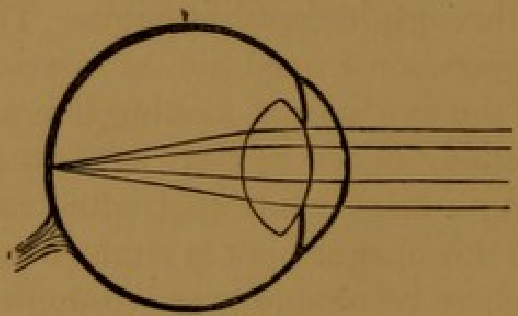


Fig. 1.

to reach the retina except through this hole in the iris. The iris is a thin, delicate, vascular and muscular membrane, covered with black pigment on its posterior surface, and forms a perforated screen or diaphragm like those we have in optical instruments, as the spy-glass or microscope. Notice the size of the pupil when exposed to the light, then cover the eye with your hand for a second or two, and suddenly remove it. You will see the pupil has enlarged, but contracts suddenly again on exposure to light. The muscular contraction and expansion of the iris, therefore, serves to regulate the amount of light admitted to the eye, and adapts it to the ever-varying amount it is constantly exposed to. Now this vascular and muscular diaphragm, the iris, is very frequently the seat of inflammation, due to a variety of causes. When it is inflamed there is a secretion from its surface called lymph, which fills up the pupil and is finally organized into a whitish and opaque membrane, entirely preventing the light from passing through the pupil to reach the retina. If you look at the diagram (*fig.* 1), you will see that the pupillary edge of the iris rests against the anterior surface of a double convex lens, the crystalline lens. If there is inflammation the iris is liable to be fastened down to this lens, and cannot, therefore, dilate or contract, and its attempt so to do with the varying intensity of the light, will aggravate the inflammation by dragging the tissue of the iris. For this reason, the moment the ophthalmic surgeon finds there is trouble with the iris — a fact which he knows by various symptoms — he applies a solution of atropine to the eye. Atropine, by dilating the pupil and keeping it so for several days, as well as being of other special service, thus prevents the iris from attaching itself to the lens, or the little capsule in which the lens is held. It is therefore an invaluable remedy as applied to the eye, but a powerful poison when internally used in too large doses.

Supposing now the pupil is blocked up by a mass of opaque and tough lymph, rendering the patient quite blind, what can be done to give him sight again? The surgeon simply makes a hole through the iris at some other point, and the patient can see through *it* nearly as well as he could through his natural pupil. The various methods of performing this operation I need not, of course, dwell on here.

The clear part of the eye in front looking like a watch-glass, may, from disease, ulceration, injury by burn or scratch or cut, become quite opaque, forming a large white spot, often called a *pearl* by the community. When this opaque spot is situated in front of the pupil, the patient will of course be unable to see through it, and proportionately blind. Now, if we remove a piece of the iris and thus make an artificial pupil somewhere else, behind a *transparent* portion of the cornea, then the rays of light can again enter the eye and go to the retina, and sight will be restored; a delicate but successful operation. (*Fig.* 2.)

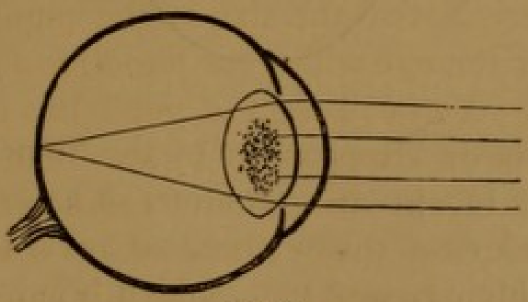


Fig. 2.

Again, in *fig.* 2 we see the centre of the crystalline lens opaque with cataract, of a character frequently congenital. This stops the rays of light so they cannot reach the retina. The pupil has, however, been widely dilated with atropine, and we notice the rays of light can pass through the outer clear portion of the lens. We cannot, however, keep the pupil always dilated with atropine, and even if we did we should have a circular pupil not serviceable for good vision. The surgeon therefore removes a small piece of the iris, or makes a slit in it over the clear part of the lens, and useful vision is obtained for the patient.

The cornea sometimes loses its natural curve, and becomes conical in shape. This excessive convexity is found generally in the centre, directly, therefore, in front of the pupil, and it may so interfere with sight as to oblige us to form an artificial pupil away from the central part of the cornea, where the curve is not so great. The operation also has a definite action in retarding the gradual giving way of the cornea, and its further bulging.

All these cases I have so far mentioned are where we desire to avoid the excessive curvature of the cornea, or simply wish to let the light through a clear space into the eye to reach the retina. An artificial pupil, however, is much more frequently made for a very different purpose, and the operation is then called an *iridectomy*. This is an invention of the late lamented Prof. Græfe, of Berlin, Prussia. He found that the removal of about one-sixth of the iris, carefully carried up to the outer edge or junction of the iris with the external coating of the eye, so as to leave a pupil of the shape in the adjoining cut, was a very powerful prophylactic remedy in very many affections of the eyeball and its membranes. (*Fig.* 3.) One of the ways this truly wonderful operation of iridec-

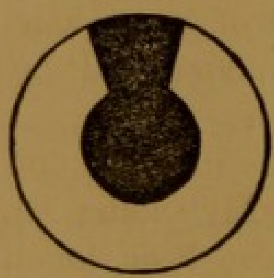


Fig. 3.

tomy acts, is to decrease the pressure of the humors in the eye when they are secreted in too great quantities, so as to render the eyeball tense and hard, and thus cause pressure on the nerves within the globe, thereby producing, perhaps, sudden blindness. The several affections of the eye in which iridectomy has been found to be valuable, are very numerous. When the cornea is injured or diseased, and softened by ulceration, iridectomy may prevent its bursting, and thus save the eye. When an ulcer has made a hole through the cornea, or a wound has left an opening in it causing what is called a fistula, then the aqueous humor constantly flows off through this hole, and the lens forces the iris up against the cornea, preventing the fistula from healing up. Here an iridectomy, properly done, changes the whole condition, and gives opportunity for nature to repair the damage. I said that when the cornea bulged too much in the centre, we made a pupil at one side. Now when the cornea is gradually giving way from pressure of the fluids inside, no matter where the point of enlargement may be, or from whatever causes, softening from ulceration or otherwise, then an iridectomy, well performed, prevents or arrests further bulging, by reducing the pressure on the inside of the eyeball. So also if there is a bulging, or *staphyloma*, as it is called, of the globe, beyond the clear part or cornea, *i. e.*, of the white of the eye, no matter whether it has originated from constitutional causes or some remote injury to the eye, then a well-timed iridectomy may arrest the trouble and prevent imminent blindness, probably, by reducing the intraocular pressure.

When by any injury, such as the puncture of a knife, needle, fork, etc., the crystalline lens has become wounded, it is apt to swell up and cause pressure on the iris, and very great pain and danger. Here also we perform iridectomy, removing the piece of iris so pressed on. In the present operation for the extraction of cataract, we always make an iridectomy before removing the opaque lens, whereby we avoid the dangerous pressure on the iris, or its being torn whilst the cataract is pressed out of the opening we have made in the eyeball. Again, the crystalline lens, when by a blow on the eye, or a jar, a thrust, etc., it is dislocated from its position, may cause this dangerous form of intraocular pressure and hardness of the eyeball, which can be relieved only by an iridectomy, or removal of about one-sixth of the iris.

There are certain forms of inflammation of the iris which resist all the remedies which ordinarily subdue such painful and dangerous affections. Here it has also been found that an iridectomy is of great assistance; in fact, often our last and only means of checking a disease fatal to sight. When there is chronic or acute inflammation of the iris, together with that of the membrane inside of the eye, called the choroid coat, which is also very vascular, like the iris, then a proper removal of a part of the iris, an iridectomy, may stay the disease and enable nature to repair, in part or whole, the mischief.

One of the most insidious forms of disease the eye is subject to is what has been called *sympathetic inflammation*. That is, an injured or diseased eye, no matter how or from whatever cause, may at any time, perhaps years afterwards, bring on inflammation in its fellow eye, till then quite sound and healthy. This form of trouble is very much dreaded by the ophthalmic surgeon for his patient, as the symptoms are not often at first pronounced enough to cause the latter to apply for advice at a sufficiently early period, when a timely and judicious iridectomy might save sight in the eye. But this can never, of course, take the place of the necessary removal, by what is called enucleation, of the other injured and now useless as well as hurtful eye. We always remove the eye that has been hurt, and perhaps perform iridectomy, in addition, on the other.

Possibly one of my readers may have read, or heard of, or seen, some unfortunate person, who having had sudden and acute pain in the eyeball, with rapidly diminishing sight, has become almost or totally blind within twenty-four, or even twelve hours. At any rate such a thing is possible, and only too fearfully frequent. Apart, of course, from any injury to the eye, there is but one disease which can produce such sudden blindness, and till within about fourteen years this terrible disease always caused the loss of sight. The affection which I mean received, a great while ago, the name of *glaucoma*, a word derived from the Latin *glaucus*, or green, because the pupil of the eye presented a greenish yellow appearance instead of its natural jet black color. As I have said, twelve hours may be time enough for this disease to render its unfortunate victim totally blind, but it may also assume a chronic form, and be months or years in producing the same result, or a comparatively slight acute attack may be followed by insidious chronic exacerbations. This is an affection so fatal to sight, and now, as we shall soon see, so amenable to proper treatment, that I pause here to speak of some of the symptoms accompanying it, in order that any of my readers so unfortunate as to be attacked, may perhaps be thus enabled to recognize the disease, and seek at once for proper treatment from the nearest ophthalmic surgeon who is able to afford it. Let them, however, remember that this will assuredly not be obtained from any one who advertises in any shape, manner or form, by newspaper, circular, handbill or card. In this country the charlatan has perfect liberty to advertise, and absolute legal power to fleece his victims.

The symptoms of this disease, glaucoma, are first an increased tension of the eyeball, either intermittent or constant. This is a very important and very definite symptom, and one which points to immediate operation. Another symptom is, of course when the disease is chronic, a rapid increase of old sight; I mean a person requires stronger and stronger glasses within a few months. Besides these signs, the humors of the eye, the aqueous and the vitreous, become cloudy or hazy. The pupil is dilated, and very slowly contracts when a strong light is brought to bear upon the eye. The patient also has now and then indistinct vision, all objects appearing clouded or veiled. He also may see a halo or rainbow around the candle. He has pains more or less acute in the forehead, temples, and down the side of the nose. The field of vision is contracted, he cannot see plainly over as large a space in front of him as previously. Of course, in an acute attack of one day's duration, all these symptoms are condensed into much less time, and the poor victim will principally complain of the fearful pain, as if his eyeball would burst, very likely having detected that it was as hard as a marble to the touch, and very tender. In 1851, Prof. Helmholz invented the peculiar mirror to be described in a future article, called the ophthalmoscope, by means of which we are enabled to examine most minutely the interior of the human eye. By means of this instrument my friend and instructor, Prof. Edward Jäger, of Vienna, had, in 1853, noticed the very peculiar appearance of the optic nerve in the eye during this disease, glaucoma. Prof. Græfe, of Berlin, followed out this, and with masterly skill connected the various symptoms and morbid appearances, finally deducing the fatal effect of glaucoma to be due to the increased intraocular pressure as shown by the tension of the eyeball, and discovered one of the most brilliant results of modern surgery; namely, that an artificial pupil, or excision of a piece of the iris, an *iridectomy*, relieved this pressure within the eye, and saved the patient from blindness.

As may be naturally supposed, before the invention of iridectomy for glaucoma patients suffering from this disease were treated in various ways, and often very heroically, since they naturally demanded some relief from fearful pain, no matter how obtained. Leeches, mercurials, antiphlogistics, diuretics, diaphoretics, cathartics, etc., etc., in the way of medicines, and puncture of the eyeball in the way of surgery, all were of no avail, and but few of them readily used in a disease sometimes running its course in perhaps four-and-twenty hours. Therefore, the brilliant success of timely iridectomy for a person suffering agony all night and stone blind in the morning, by relieving the pain at once and entirely, and permanently restoring useful vision, can hardly be thoroughly appreciated except by the unfortunate patients, and those who have had the happiness to have thus befriended them. Other operations have been devised, and carried out to relieve glaucoma, but none compare with iridectomy. It is a curious fact that the more sudden and severe the attack, the more sure and permanent is the relief by this operation. This fearful disease, glaucoma, may attack one eye directly after the other, and therefore both patient and surgeon must be prepared, the former to submit to, and the latter to carry out a second operation on the other eye. The patient must never be allowed to go away out of reach of immediate surgical aid, till some time has elapsed. I trust I have thus taught my readers a little about a serious malady affecting principally the middle-aged and old people, and also, I hope, induced them to have a still greater respect for modern science, and those availing themselves of it honestly and diligently in relieving suffering, and promoting human welfare and happiness.

I suppose now my readers have a sort of curiosity to learn just how the ophthalmic surgeon makes an artificial pupil, or performs an iridectomy. With a lance-shaped, delicate, flat knife, he pierces the eye in front of the iris, then passes in a pair of very fine forceps through the wound, grasps the iris with them, and drawing it out, snips it off with small, sharp scissors. Of course such an operation, although sounding so simple, is in reality a very delicate one, requiring skill and experience on the part of the surgeon.

It is a maxim of surgery never to operate unnecessarily, but never to hesitate to operate. Moreover, we always strive to find and carry out less severe and equally useful operations, an instance of which is here directly in place. I said above that the pupillary edge of the iris rested against the crystalline lens, so that when adhesive inflammation took place in the iris it was liable to be fastened down by little tags, as it were, to the lens, or rather its capsule. These little cuts represent three such cases drawn from nature. The pupils are not dilated evenly and round by the atropine put in the eye, the adhesions preventing it. (*Figs.* 4–6.) Now these attachments, by

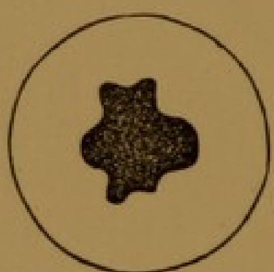


Fig. 4.

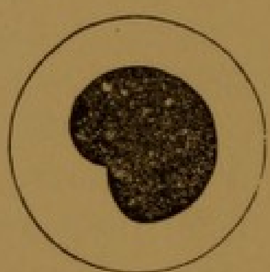


Fig. 5


Fig. 6.

dragging on the iris, are the fruitful source of repeated attacks of inflammation, and attempts have been made to separate them, and with some success, but not enough to warrant continuing the operation. If these tags were many, and the pupil small, and filled also, perhaps, by more or less opaque membrane, then we had formerly no other method of treatment than the making an artificial pupil through another part of the iris, or an iridectomy was performed, embracing as many of the tags as possible in the portion of iris removed, to counteract the recurrent attacks of inflammation of this membrane. A German physician, Dr. Passavant by name, has within two years discovered that these attachments may be broken up by making a small opening in the cornea, and through it, with very delicate forceps grasping the iris gently, and pulling on it till the attachment breaks away. This, of course, has to be done for each, or nearly each attachment. It is found to produce very little irritation of the eye, and to finally leave the pupil round, and the iris free to contract and expand without danger of irritation. All these cases above were thus operated on with perfect success, and this operation is now regarded as a great advance in ophthalmic surgery, since we are thereby enabled to restore the eye to its natural condition with much less operative interference, which every true surgeon always strives for. These delicate operations we have thus described in this article, are of course rarely if ever attempted by advertising licensed charlatans. They avoid them for evident reasons, and generally succeed in obtaining what they want—namely, their clients' hard-earned money—by persuading them to *pay so much down*, or so much a month, or to purchase vast amounts of useless or hurtful drugs. This the law allows, and protects them in doing, whilst the people are the lawgivers.

THE OPHTHALMOSCOPE:

What it is, and How it is Used.

PROBABLY many of my readers have had their eyes examined by an ophthalmic surgeon, or seen him examine those of some friend, with a peculiar form of reflecting mirror called an ophthalmoscope. By means of this instrument the observer is enabled to have a most perfect view of the interior of the eyeball, which, till this invention, was a closed and darkened chamber to the surgeon. Now, that which is within the eye is as much under his inspection as the external parts of the globe. Of course such an assistance to the observation and study of disease entirely revolutionized ophthalmic medicine and surgery, and it has led some of the most brilliant intellects to devote themselves to this difficult branch of the medical profession, whereby very great advance has, within the last ten years, been made in the science of ophthalmology. This has been recognized by general physicians, who very properly do not feel themselves called upon to keep pace with such studies and practice, which they consider must be left to those devoting themselves especially and exclusively to them. All the text-books on physics teach a certain amount in reference to the ophthalmoscope, as if it were an optical instrument to be understood like the microscope. I will therefore endeavor to give my readers some account of this invaluable instrument, and how it was invented, as it is a curious chapter in physics, and they will perhaps only wonder with me that it was not thought out before. It must be remembered that it was not an accidental discovery, but was *thought out*, or invented. It is one of the greatest boons of exact science to medicine, and has directly led to the invention of other optical instruments for the examination of the closed cavities of the human body. Let us see how the study of some of the natural phenomena of the eye gradually paved the way to the invention of the ophthalmoscope.

Probably all of my readers have at some time noticed the pupil of the eyes of our domesticated animals, for instance the cat or dog, light up suddenly, appearing of a bright color, or, as the phrase goes, glaring at you out of the dark or twilight. The pupil of the human eye is simply a round hole through the iris or colored part of the eye. All the media, as they are called, behind the cornea, the aqueous humor, the crystalline lens, and the vitreous humor, are perfectly transparent, so that they do not prevent us from looking through them to see the optic nerve where it enters the eyeball, and the little arteries and veins coming out from its centre to be distributed to the expanse of the retina on the inside of the globe. There must therefore be some reason for the pupil of the human eye appearing black. Like the animal's eye, however, it also sometimes lights up, or suddenly appears red. This is not infrequent with those people whose pupils are large, as in young persons, or when the pupil has been dilated with atropine. It is so striking a phenomena as to be naturally quite startling, and probably gave rise to the idea and the expression of the eyes "flashing fire." I knew several people in whom I have repeatedly seen this phenomenon. It is, however, due to the same cause as with the animal's eyes. This natural effect was for a long time suppôsed to be produced by the eye *emitting* light from its interior, with the idea that it was phosphorescent. It will be worth our while to follow along historically this point of the supposed illuminating power of the eyes of animals. Aristotle, amongst those bodies which we now call phosphorescent, included the head, scales, and *eyes* of fishes. Since we now know that the interior of the eyes of several species of fish are lined with a brilliant colored pigment, we easily recognize why they were supposed to have the power of emitting light. Plinius speaks definitely of the lighting up in the dark of the eyes of the nocturnal animals, as the cat. Goats also, and wolves, are mentioned as emitting light from the eyes. It has therefore evidently been for ages noticed that the eyes of the nocturnal beasts of prey light up in the dark. The same form of illumination of the human eye was likewise occasionally observed, the first mention of which is by Fermin in 1796, in the case of an Ethiopian albino. Now and then the same fact was noticed and recorded more especially, of course, with albinos. Naturally enough all sorts of ridiculous and superstitious ideas were connected with this natural phenomenon, some people drawing such a long bow as to say that those in whom it was observed had the power of illuminating objects in the dark, the absurdity of which we shall soon see. In some diseases, also, of the eye, the pupil had been seen to lose its normal black appearance, and assume some peculiar color. Scarpa saw this in 1816. Beer, in 1817, saw a concave yellowish white reflex from deep in behind the pupil. Canstatt, in 1831, relates nearly the same. Behr, in 1839, first spoke of the lighting up of an eye neither albino or diseased. It was a case where the iris was entirely absent. Prof. Brücke, in 1847, suddenly saw the pupils of a young man light up as he turned towards him on leaving the room. Cumming had, before Brücke's observation, shown how the pupil could be made to light up. The first accidental use of the principle of an ophthalmoscope was thus: Dr. Von Erlach, in Berlin, was sitting one evening in the corner of a sofa engaged in conversation with a friend sitting in the other corner. They were leaning toward each other, and a lighted candle was on the table in front of them. Suddenly Von Erlach saw the pupil of his friend's eye become a bright red instead of black, and noticed that it occurred when the reflection from the glass in the spectacles he wore was thrown on his friend's face. His friend put on the glasses, and also perceived the same effect in Von Erlach's eyes. The latter spoke of and exhibited the phenomenon at a scientific society then holding its meetings in Berlin. It was not till 1851 Helmholz studied the course of the rays of light entering and leaving the eye, and thereby invented the ophthalmoscope.

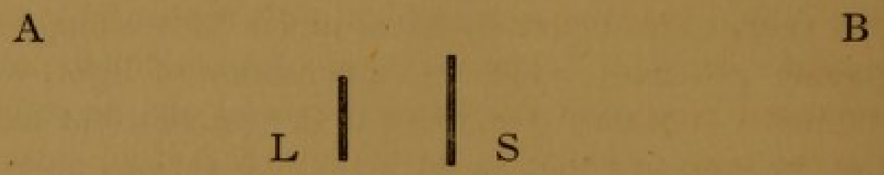
In 1831 Canstatt seemed to settle the question, and his statement was generally accepted, that the pupil's appearing normally black was due to the black pigment lining the interior of the eye. He said, "this is so clear that it needs no further proof." But here, as usual, truth is stranger than fiction. The idea of the eye being phosphorescent, and emitting light through the pupil, however, prevailed to a considerable extent, and animals were really thought to emit light in absolute darkness. Dessaignes, in 1809, in a prize essay before the *Institut de France*, states, "animals' eyes have the power of lighting up like a flame, in the dark." How the phosphorus got into the eye to emit light, was variously explained. Even Buffon said, "the sunlight which the eye drinks in by day, streams out again by night." Others had the idea that light was emitted through the pupil like the flash from the fire-fly. As late as 1818, Treviranus said, "In both men and cats, the lighting up of the eyes seems to occur more often in summer than winter, particularly at certain times, and with cats, perhaps also at a certain age. The cat's eye lights up when she is waiting in ambush, or meets something strange, or is enraged." "The light comes undoubtedly from the interior of the eye; whether from the retina, and not from the choroidal pigment, experience has not yet decided."

The illumination in the human eye was likewise referrred to phosphorescence. Electricity was also called in to explain this phenomenon. Peter Pallas, in 1811, attributed it to electric light from exposed nerve substance within the eye. About this time, however, phosphorus and electricity had to be given up as the cause of the pupil's occasionally appearing red instead of black. In 1810, Prévost, in the Bibliotheque Brittanique, Vol. 45, published his researches on this interesting subject, of the illuminating of animals' eyes, and by observations on living cats, disproved the phosphorescence theory. He finally showed that the illumination of the cat's eye, as well as of other animals exhibiting the same phenomenon, was due not to phosphorescence, but to the reflection back of the rays of light which entered the pupil, and therefore was neither dependent on the animal's will, or its state of excitement; that it also did not appear in complete or very great darkness, and that it could in no manner assist the animal in finding its way in the dark. This was of course too simple a truth to be readily received, but Groithuisen, also, in 1810, propounded the view that the illumination was due to the reflection of the light from the layer of pigment in the back of the eye. Groithuisen was completely supported in his idea by Rudolphi, who, in 1821, was the first to call attention to the very significant fact, that a certain relative position of observed and observer was necessary to produce the effect. He showed also that it occurred as well after death as before, the eye in the animal's decapitated head lighting up as well as when the creature was living. He explained the illumination of the albino's pupil, by the rays of light being reflected from the bottom of an eye in which the natural pigment was absent.

Now, when the pupil of an animal's eye becomes thus suddenly brilliant, we sometimes see a red color, at others a green, etc. Esser, in 1826, first distinctly showed that these colors were dependent upon the color of the pigment in the bottom of the eyes of the different animals. He also clearly stated, that if the room was dimly lighted, and the light which came in fell upon the cat, for instance, whilst the observer placed himself between the light and the animal, and looked in the direction of the incoming light, then the pupils were most readily seen to be brilliant instead of black. Johannes Müller, in the same year, 1826, definitely says, in his "Physiology of Vision," that pressure produces in the eyes a sensation of light, which it has been claimed is not only subjective to the person, but also objective to another person, and that the brilliancy of various animals' eyes in the dark has been referred to this cause; but, he adds, this light does not originate in the eye itself, being simply a reflection from the bright pigment in the back of the interior of the globe, the dead animal's eye shining the same as when the creature was alive. The red color was, by Hassenstein, referred to a sudden influx of blood into the part. In 1845, Ernst Brücke published in Müller's Archives his anatomical researches on this point, of the lighting up of the pupils of the eyes of the vertebrate animals. He of course especially studied the living membrane inside the eye, of different colors in various animals, and quite disproved Hassenstein's idea, showing that the red color from the dog's eye was not due to a sudden influx of blood into the part, but from the *normal* condition of the blood-vessels being filled with this fluid.

In 1845 a prize had been offered by the Medical Faculty of Heidelberg, for a dissertation on this subject, which Kussnal received for an essay in which the principal new points brought forward were, that the pupil is ordinarily too small for sufficient light to enter, and hence it appeared black, and the pigment lining the interior of the globe absorbed the light.

It was not till 1846, that Cumming, in the 29th vol. of the Medico-chirurgical Transactions, explained the pupil's lighting up, and showed how it could be readily done. He said, let a person stand some ten or twelve feet from a gas, or other bright light, the rays from which must fall directly on his face in the line he is looking. A screen placed half way between him and the light, casts off all rays except those coming to the eye. Now, if much light is reflected from the pupil, it will be seen at any point between the lamp and shade. Soon afterwards, Brücke, entirely independent of Cumming, showed how to illuminate the pupil; thus: a person sits in a dark room a few feet from a bright lamp, and looks just over and by it. On the other side of the lamp close to it is a screen, reaching high enough to simply cover the flame. Let any observer, also on the other side, look over the edge of the screen towards the eye of the person observed, and the latter's pupil will be seen bright colored. The relative positions are thus: A, is the person observed, L, the lamp which should be at the height of his eye, S, is the screen to keep the light from B's eye, who looks into A's pupil just over the edge of the screen.



I have thus followed out the history of this interesting subject, as it will be seen how the natural phenomena were studied, and how gradually truth came to light. So far, however, it will be noticed that we only found that it was the light entering the eye which, reflected back, made the pupil light up, and this light was of course of the color of the surface which reflected. This would have been of no special value to the ophthalmic surgeon without further discovery. We need to see the details of the structures within the globe to be able to decide if they are diseased; or, if some foreign body has entered the eyeball, we must see it clearly to decide what it is, and whether it may be removed, etc. Now the optic nerve, when it enters the eyeball, is a pale yellowish white disk, or a pinkish red, and the blood-vessels of the retina which enter in the centre of this disk, spread out from these in beautiful ramifications, perfectly distinct and clear under the ophthalmoscope, and we shall soon see how this instrument became developed, from all the facts hitherto known. It is, however, a very curious fact, that as early as 1704, Mery, in the Royal Academy of Sciences, had said, he saw through the pupil the blood-vessels in the bottom of a cat's eye, when the animal was under water. In 1709, De la Hire, in the same publication, had explained this fact, and showed exactly how it was caused, by the effect of the water preventing the cornea acting as a convex refracting surface. From that time, placing the eye under water to enable us to see the interior was occasionally practised, as by Prof. Arlt, of Vienna. In 1851, Czermak invented a little instrument for holding water round the eye for this purpose, called the othoscope. It is a sort of little reservoir of glass having three sides, and when placed against the cheek and nose, and filled from above with water, the eye can be kept opened in it under the water. We can look into the eye through the glass in front, and the transparent water.

This brings us now to Prof. Helmholz's invaluable invention, the ophthalmoscope. In 1851 he published a little pamphlet entitled "Description of a Mirror to examine the Retina of the Living Eye." He studied the subject from a purely scientific point of view, and argued thus: if the pupil does not appear ordinarily black because the retina is transparent and the light is absorbed by the black pigment of the choroid, and granting that the choroid and retina both reflect but little light, yet there is the brilliant optic nerve and the ramification of the retinal blood-vessels, which must reflect light to a considerable extent. He said, when we look at a candle flame there is a bright reversed picture of the flame pictured on the retina, just as there is in the *camera obscura*, for the eye is nothing else, optically speaking. The accompanying diagram explains this readily. We see the rays of light going from the candle, and forming a small reversed image on the retina. (*Fig* 1.) Helmholz therefore rightly concluded that it was owing to the refracting media of the eye, the cornea, lens, and vitreous humor, that we could not look into the eye and see the bright inverted image of the candle; a very easily performed and simple experiment will prove this to you at once. Make a little pasteboard cylinder three inches long and one inch in diameter; blacken the inside with ink; now cover one end with a colored card on which you have drawn a small cross, we will say, or a letter. Let the letter come in the centre of the cylinder. Look in at the other end, and of course we have no difficulty in seeing the cross or letter. Now place over the open end a double convex glass of three inches focus, and try to look through it to see the cross, and you will find you cannot. Looking at it through the ophthalmoscope, you can again see it distinctly. Helmholz studied the rays of light which came back from the retinal picture, and found, as is seen by looking at *Fig.* 1, that they were focused by the eye exactly

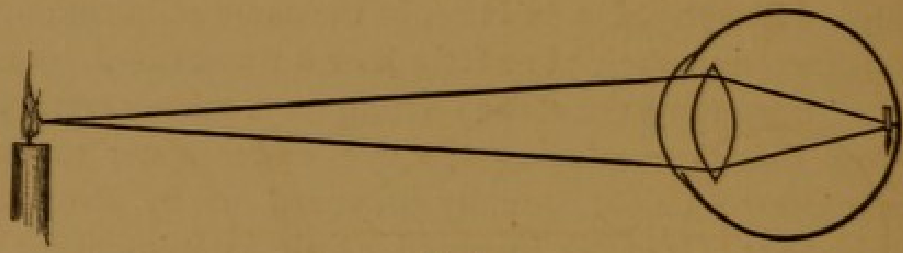


Fig. 1.

where they started from, namely, the candle. Anywhere between the candle and the eye we could see them; but if we put our head there, we *simply stop any light from coming from the candle to go into the eye and illuminate the optic nerve and retinal vessels, so as to render them visible.* This is the whole story, and the only reason the pupil appears black. Here we see, as always, that the simple truth is really stranger than any fiction of phosphoresence of the eye, or the absorption of light by day and its emission by night, or in the dark. The problem was thus reduced down to getting the light into the eye and letting it come back to *our* eye, so we could see the interior of the one we look at. Helmholz solved this in the following beautifully simple manner. He reflected the light into the eye by a plate of plane glass, and the light coming back from the interior of the eye, passed, of course, through the transparent glass, and could enter the eye of the observer placed behind this glass, and he would thus have painted on his retina the picture on the retina of the eye he was looking at; or, in other words, he saw all the details of the interior of that eye. (*Fig.* 2.) This diagram, *fig.* 2, will make the matter quite clear. A is the candle sending out rays of light, which I here represent by a single one, to B a piece, or three pieces, of plane glass, highly polished. These, of course, reflect the light into the pupil of C, the eye we are looking at, and illumine its interior. Now every illumined object sends out rays of light in all directions, and those passing back through the pupil, as I explained with *fig.* 2, go to the reflecting surface, and from there back to the candle; but this reflecting surface is transparent, and some of the rays must pass through it, so that our eye, if just behind and in a line with them, as D is, then they can enter our pupil, and thus on our retina will be depicted all the details of the bottom of the eye we desire to examine. Such, then, was Helm-

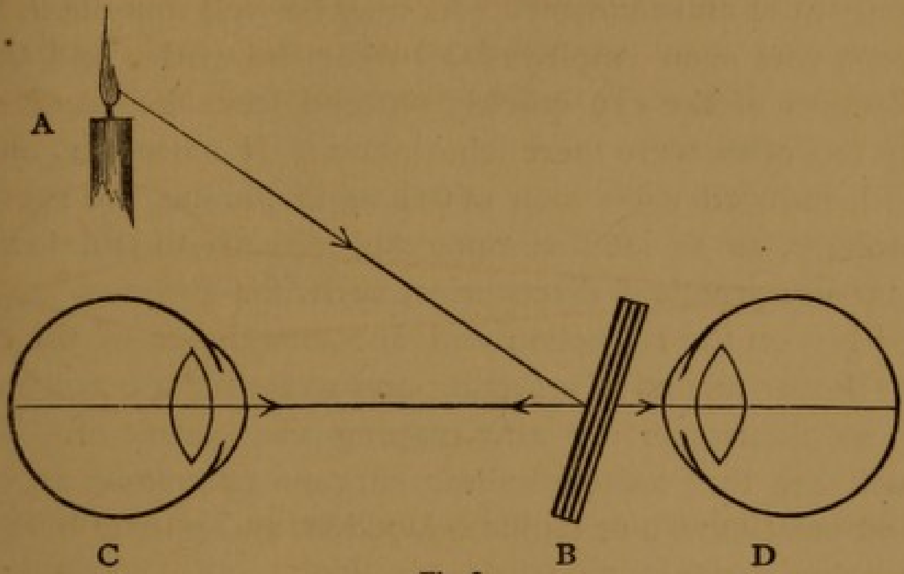


Fig. 2.

holz's invention, and such its beautiful simplicity. Afterwards Prof. Ruete invented another form of reflecting mirror of polished steel or silvered glass, and to let the rays into the observer's eye, he made a *small hole in the centre*, through which they passed. A piece of looking-glass with a little place on the back where the silvering is scraped off, will represent such an ophthalmoscope.

There is much more of optics and the laws of reflection and refraction of light applicable, and to be understood in the practical use of the ophthalmoscope. These the ophthalmic surgeon must master completely, to be able to use this instrument to any advantage. Of course, as soon as the mystery was solved and the way pointed out, there were a variety of means devised for attaining the desired object of illuminating and observing the interior of the eye. They are, however, of no special interest here. I will merely mention that there is a form of ophthalmoscope by which we are enabled to use both our eyes, and thereby get a binocular or stereoscopic view of the interior of the globe. Another, somewhat on the principle of the "ghost" used in the theatres recently, enables the teacher and student to see the details of the bottom of the eye at the same time. Still another enables one eye, for instance, the right, to examine the inside of the other, or left. And finally a very simply arranged ophthalmoscope enables an eye to *see its own interior*, the optic nerve and ramifications of the retinal vessels. This is as far as science has at present gone in this direction. We see now how pure science and its cultivation leads directly to the most wonderful, invaluable, and *practical* results. Never, then, let us speak of science lightly or sneeringly. So-called self-made men don't invent ophthalmoscopes, it comes from years of hard work, with toiling brains and patient study and industry. As may be well imagined, the ophthalmoscope was soon employed all over the world, and the study of the diseases of the eye quickly rescued from the hands of those who only too often were mere charlatans. It moreover, as I have above said, induced such men of talent to pursue the specialty of ophthalmology, as to lead at once and directly to still further and most eminently practical discoveries, such, for instance, as those of Prof. Donders on the refraction and accommodation of the eye, and hence the proper means of selecting and adapting spectacles, a boon hundreds of thousands are now reaping the benefit of. Thus my readers will see that an ophthalmic surgeon cannot be an ordinary quack, and must have a scientific education, and pursue his specialty with unceasing assiduity.

But still further, Prof. Helmholz, in his original little pamphlet, modestly says: "I think by means of the ophthalmoscope we shall be able to determine the optical condition of the eye, independent of its visual power, and the statements of the person examined." This is in reality just what, during the last two years, the scientific ophthalmic surgeons have been doing, and I confess it is to our discredit not to have done it before, as nearly twenty years have elapsed since Prof. Helmholz told us how this could be done. By examining the eye with the ophthalmoscope we find out directly what glass is required for the patient, and can select it within one or two numbers, this in spite of anything the patient may say or do, should he be disposed to deceive us. This, my readers will see, is very different from the only too frequent method of the venders of spectacles letting their customers try on one after the other, and pick and choose for themselves. Optician and ophthalmic surgeon, or oculist, as the community designate us, are two very different persons. The best opticians follow the directions as to the number and setting in the frame of the patient's glass chosen and tried by the ophthalmic surgeon, just as the respectable apothecary follows the direction of the physician in compounding the medicine prescribed. I have elsewhere perhaps sufficiently warned against the dangers of the indiscriminate choice and wearing of spectacles, tinted glasses, et cetera.

INJURIES AND DISEASES OF THE LIDS AND EYE: Their General Care and Treatment.

I HAVE previously spoken of all sorts of foreign bodies getting into the eye and adhering to the eyeball, or lying concealed under the lids, and how these can be seen and removed; such as specks of dirt, or coal, cinders, particles of metal breaking off from tools in the workman's hands, or pieces of stone or emery flying from rapidly revolving polishing wheels, etc. When these simply adhere to the eyeball or lids, they are, as I said, frequently readily removed by some fellow-workman, who has acquired some skill or reputation for this sort of thing in the particular establishment where the accident occurs. When, however, any foreign body has penetrated the delicate skin lining the lids and eyeball, or the clear part of the eye in front, the cornea, then their removal is quite another and more difficult manœuvre. Only too many days' work are lost, and even eyes destroyed, by ignorant and unskilled "working" on such "somethings" in the eye. If the method I have previously described does not succeed in removing a foreign body that is stuck in the eyeball, the best surgical advice should be sought at once, as every hour of delay is one of increasing danger. Young eyes, a steady hand, and experience in detecting and removing these substances, are required on the part of the surgeon. Jack-knives, pins, steel pens, etc., are not the instruments he uses for this purpose, and therefore can hardly be more efficacious in the hands of those who, nevertheless, constantly employ them to "worry out" an offending splinter of stone or metal from some fellow-workman's eye.

Injuries of the Lids.

The bites of many insects, the poison of some plants, such as *arnica*, now so frequently prescribed and used, will cause the lids to swell up so as to close the eye, and frighten the patient and those about him. But there is generally no injury done to the eyeball, and hence no danger for the sight. Blows over the eyes, a "black eye," produce also swelling of the lids not in any way dangerous, provided the eyeball has not been pressed or crushed. When the lids have been bruised or cut by injury, surgical advice should, if possible, be always at once sought, since the separated parts must be brought most carefully together, that they may unite and prevent what so often occurs, namely, deformity, discomfort, or destruction of the globe from the loss of its necessary protection, the lids. All burns on the outside of the lids are especially dangerous, because the contractions of the skin after healing may distort the natural and necessary curve of the eyelids, to adapt them to the eyeball.

Injuries of the Eyeball.

Some sudden, violent exertion, sneezing, coughing, a blow, etc., may cause an effusion of blood under the delicate membrane covering the eyeball, and change the white of the eye to a blood-red, giving rise to anxiety. Such an effusion, if it is only this, is of no consequence, as the blood becomes absorbed in a few days. Cold water is the only application which should be made. Poultices, spirit and water, arnica, quack medicines, etc., only retard nature's cure, and may do irreparable mischief. They will, however, all be used, so long as the newspapers recommend proprietors' advertisements of patent medicines in their columns, and old herb-women, with the whole tribe of quack doctors and venders, sell them.

Blows on the eyeball that have not caused any apparent harm — I mean no bruise, or redness, or noticeable change — frequently produce extreme pain, and temporary dimness, or loss of sight, with inability to bear the light. The tears flow rapidly, and the lid is kept tightly closed. If this state of things last but a few hours, the eyeball may escape harm, but such an eye should be most carefully watched, as dangerous inflammation steals on most insidiously. Such blows come from corks flying from bottles, pieces of wood jumping from the block, balls thrown in games, etc.

Shaking of the eyeball from a blow may, without any visible external injury, be followed by immediate partial or total loss of sight, and the pupil be seen dilated. A continuance of this state of things for more than an hour or two, points to some internal injury which the concussion has produced, a rupture or tearing of the iris, or some of the internal membranes, or a dislocation of the crystalline lens. Sometimes a blow on the eye causes temporary pain, which passing off, and the sight remaining sufficiently good, the person continues his occupation, and in a few days is suddenly stricken down with intense pain and inflammation in the globe, that only too rapidly destroys the eye forever. In such a case some accident has occurred within the eyeball, which the ophthalmoscope would have revealed to the surgeon, and proper treatment have prevented from resulting in harm. The only treatment for all these forms of injury till proper advice can be obtained, is a rag wet with cold water laid over the eye, and possibly one or two leeches applied to the temple, not near the eye, but back just in front of where the hair grows; with, of course, rest and quiet on the sofa or bed, and avoidance of light and the use of the eyes. Such a plan of treatment would often save eyes now only too frequently sacrificed to prejudice, ignorance, and licensed quackery.

Penetrating Wounds and Rupture of the Eyeball.

When the eyeball has been hurt by a blow, or cut open by a sharp instrument or fragment of metal or glass, immediate proper care is necessary, which the ophthalmic surgeon alone can give. Poultices and washes of all forms generally succeed in destroying the eyeball. The crystalline lens may be partially or wholly dislocated, requiring an operation for its removal, or it may have been touched by the instrument causing the injury, and then become gradually opaque, thus forming a cataract that only an operation can remove. Blows and cuts may also produce bleeding within the eyeball, even when this is not apparently much, if any, injured. Such effusion of blood is seen by the ophthalmoscope inside of the globe; and although sight may be temporarily lost, the surgeon will be enabled to tell his patient that useful vision can once more be restored.

Wounds and cuts of the white of the eye and the clear part in front, or cornea, are likely to allow the colored portion of the eye, which is a delicate vascular membrane, to protrude, and become fastened in the wound. The pupil is then partly closed or drawn together, so that an operation becomes necessary to free the iris, or form an artificial pupil. Simple puncture of the clear part of the eye, or cornea, when caused by a fine sharp instrument such as a needle, rarely does much harm in the end, although all such wounds need the best of care for a short time. When the cornea has been cut through by some rough or irregular instrument, there is much more danger. In all such cases, without the best surgical advice nothing should be applied to the eye except a rag kept wet with cold water, and the person should remain quiet in a darkened room till assistance can be obtained. Proper treatment the first day may save the eye.

Abrasion of the Cornea.

When the transparent part of the eye has been scraped or dug by a blow from a switch, some foreign body flying against it, or the scratch of a child's finger nail, — a baby in arms, for instance, — it is a much more serious accident than the person so injured would imagine. Generally the pain is so great and so continued, that they soon seek advice, and are fortunate if that which they obtain is correct. Till proper advice can be sought, it is safest to avoid the light, to keep the eye quiet, but not bandaged or poulticed; a rag wet with cold water over it, and, if proper surgical advice cannot be soon had, a solution of one grain of sulphate of atropia in two teasponfuls of distilled water, may be dropped into the eye three or four times a day. Atropia, or belladonna, as it is called, dilates the pupil, and makes the " sight look large," as people say; it also blurs the sight for near objects. This is, however, only temporary, while the medicine is being used, and disappears in a week or less after the application is stopped. Sulphate of atropia is a *poison*, and care must be taken not to let a solution of it run into the mouth, or leave the bottle round for children to get hold of, or grown people to mistake for something else. These sort of injuries of the cornea are apt to produce, like ulcerations from disease, a white opaque spot, which is, in reality, a scar, and cannot be removed by art. If some one of the various "eye-waters" constantly offered for sale in all the apothecaries' shops, together with other quack medicines, is used when the cornea has been scratched or bruised, there is pretty sure to result a permanent white spot; *not a scar*, but a deposit of sugar of lead, which these quack eye-waters generally contain. This film, or deposit, can rarely be removed by the surgeon; and, of course, in proportion to its extent, produces more or less blindness.

Foreign Bodies within the Eyeball.

The most dangerous thing which can happen to the eye, is the lodgement of some foreign body within it. Amongst all classes of mechanics, such injuries are constantly occurring, from chips of metal flying off from the instruments they are using, or the work on which they are employed. So also in the stone-workers, metal-grinders, polishers, engineers, etc.; all of whom are thrown out of employment by the loss of an eye, and reduced from comparatively affluent circumstances to almost beggary. Amongst children, pieces of percussion caps, pins from the ends of darts, small stones or shot from bow-guns, etc., only too often strike the eye with sufficient force to penetrate and destroy the globe. It is impossible for a person himself, or those about him, to decide whether a piece of iron, or other foreign body, has entered the eyeball and *remains* there. This the ophthalmic surgeon alone can do, by looking into the eye, through the pupil, by means of a peculiar mirror, called the ophthalmoscope. He can then see the foreign body, and perhaps make a drawing of it, which the patient may recognize as corresponding to the portion which has flown off from the instrument or tool he was using at the time he met with the injury. Now this deciding whether or not the foreign body is in the eyeball, is *all important*. If it has merely cut a hole in the eyeball, and dropped back out of the eye, the patient may escape with perfect vision; but if it, no matter how small, has entered the eyeball, there is not one chance in a million of the eye's being saved, and an even chance whether the other eye is not also lost, from what is called sympathetic inflammation attacking it. In many parts of the system, a foreign body, like a needle, splinter, bullet, etc., may remain perfectly quiet and do no harm. Not so, however, in the eye; here it is fatal to sight in the injured, and perhaps the other eye also. Its presence may at once destroy the eye by exciting acute and active inflammation. After such destruction, and when only a stump of the eye is left with the foreign substance in it, this remaining portion of the globe is liable, at any time, to repeated attacks of inflammation. Even if the sound eye has not been previously attacked, in some one of these outbursts of inflammation in the stump, this insidious and dangerous sympathetic trouble comes on; taking at first the form of *weakness*, inability to bear the light, slight pain and discomfort. These symptoms increase in severity, and a gradual change takes place,— the eye degenerating, and sight being lost. The only remedy for such sympathetic inflammation, is the removal of the cause, namely, the eye, or the stump, with the foreign body in it. This, if done too late, may not save the second eye. *An eye with a foreign substance within the eyeball, never should be allowed to remain.* The present operation for its removal is so simple and effective, and the subsequent wearing of an artificial eye so facilitated, that there need be, in these days of ether, no fear or dread of the operation. It is only in the rarest instances that a foreign body has been removed from within the eyeball. A glass eye can be worn, generally, within a fortnight of the removal of an useless or painful stump or globe. Cold water, and the solution of atropine, above alluded to, are all that can be recommended, besides quiet, and protection from light, before proper surgical assistance is obtained.

Gunpowder Injuries.

The effect of these I must explain as they come from fireworks, guns, pistols, blasts, etc. There are different ways in which injury is done the eye. The concussion of the air near the eye may destroy or greatly injure it. The lids and the globe may be burnt by the powder. The grains of powder may be driven into the skin of the lids and external tissues. And finally, the grains of powder may be driven with force enough to penetrate the globe, and thereby cause such results as I spoke of from foreign bodies within the eyeball. No time should ever be lost in obtaining the best surgical aid for a person whose face and eyes are injured by a powder explosion; and in the meantime, sweet oil applied to the lids and eyes, a rag wet with cold water over these, and the dropping in every four hours of the solution of atropia, before alluded to, are all I can recommend. When seen early, much of the powder adhering to the eyeball can be removed, saving, thereby, perhaps the organ and sight with it. I cannot speak too strongly *against* the use of *everything else* than what I have described. I have seen so many eyes sacrificed to prejudice, ignorance, and stupidity, that I here again warn against poultices, washes, eyewaters, and all descriptions of patent medicines, *outside* or *inside.*

Burns from Lime, Acids, Alkalies, Caustics, Molten Metals, and Boiling Fluids.

Burns from lime in the form of mortar or plaster, are extremely dangerous; for, although they may not destroy the eyeball, they render the cornea opaque where they come in contact with it, and hence produce partial or total blindness. Moreover, they burn the inner side of the lids, and thereby cause these to adhere to the eyeball by fleshy growths, which it is almost impossible afterwards to separate so as to allow the globe to move with the necessary freedom. Olive oil dropped into the eye after it has been washed out with a weak solution of vinegar, may be used before surgical advice can be obtained.

When any of the strong acids, like sulphuric or nitric, have come in contact with the eye, they act chemically on the tissues, and hence their danger. Immediately after such an accident, the eye can be syringed out with a solution of five grains of bicarbonate of potash to two tablespoonfuls of water, and sweet oil dropped between the lids. When some strong alkali, like caustic potash, or soda, has been dashed into the eye, we may wash it out with a teaspoonful of vinegar in two tablespoonfuls of water.

Scalds from hot water, and burns from liquid metals, etc., can be treated more or less like the same injuries in other parts of the body. Sweet oil can be dropped on and in the eye, and rags wet with it laid on the outside of the lids. The best surgical advice is needed at once. Avoid charlatans and advertising quacks.

Foreign Bodies in the Orbit.

I might relate wonderful cases of this character to frighten my readers with, but that is not my purpose in any way. I simply desire to teach them how to assist in saving their eyes when injured. All sorts of things are by force sometimes driven into the orbit; like umbrella tips and handles, nails, hooks, keys, door-latches, etc. The great danger is the bursting of the eyeball, and the tearing of its surroundings, the stretching or wounding of the optic nerve, the injury done the walls of the orbit, either by fracture or by the foreign body penetrating them. The inflammation excited by a foreign body in the orbit, may prove fatal by extending to the brain. But, on the other hand, the most extraordinary cases have occurred in ophthalmic practice, where large foreign bodies have remained within the orbit without the patient's knowledge, and, when removed, the eye saved and sight restored.

It would be as impossible as out of place to attempt here to describe all the diseases of the eye, or give any plan of treatment which my readers could carry out. There are, however, some common affections of this organ that they can be taught to take care of, at least till proper medical advice can be obtained, and they may learn what *not to do* under all circumstances, if they read attentively and follow the directions I am about to give.

Sore Eyes of New-born Infants.

The best possible advice will not be too good for these cases. All sorts of quack nostrums, and old women's and nurses' prescriptions, are constantly used by even the intelligent and educated, by which many a poor child is rendered blind for life. The great secret of treatment of cases of this dangerous form of ophthalmia of new-born children, is perfect cleanliness, unceasingly carried out. This is only done by separating the lids, and with a small syringe, every two hours, washing out the secretion from the eye. Every other application, such as breast-milk, and all sorts of washes, only do harm. A physician alone can turn over the lids, and make such application as each individual case may require. The danger to the eye is, that the cornea becomes soft and breaks away, generally totally destroying the eye.

A Cold in the Eye. — Conjunctivitis.

From exposure to wind, wet, or cold, or even without apparent cause, the lining membrane of the lids becomes inflamed, giving the feeling of sticks or sand in the eye. If there is *no other trouble*, which the persons can rarely decide for themselves, some astringent solution, like five grains of borax, or two grains of sulphate of zinc, in an ounce of pure water, may be safely used. The chances are, however, and this especially with children, that there is, besides, a small ulcer of the cornea, no larger perhaps than the head of a pin, which renders the case a very different thing, and for which the treatment I speak of is quite out of place.

Iritis.

Inflammation of the colored part of the eye, the iris, is a very frequent disease, causing dimness of sight, great pain, especially at night, and intolerance of light. Leeches to the temple, a shade over the eye, and the use of a solution of one grain of sulphate of atropia in a tablespoonful of pure or distilled water, is all I can recommend till the patient can get good advice, which, I again warn him, is not obtained from any one who advertises in any shape whatever. Proper treatment *early*, in all cases where there is great pain in the eye, increasing at night, will save the sight.

Granular Lids.

The lining membrane of the lids, especially the upper one, from various sources of irritation, takes on a form of inflammation which causes it to become thickened and rough. When thus rough, the constant motion of the lids over the cornea finally inflames that delicate structure, and gradually renders it opaque, and, consequently, the patient quite blind. Moreover, this goes on till the cornea becomes soft, and gives way, by which the eyeball is of course totally destroyed. Granular lids, when they exist, can only be seen by turning over the upper lid. Now I rarely have found that patients, except when they have been under proper care, ever have had the lids turned over for the granulations to be exposed. All sorts of quack eye-waters sold in the apothecary shops, and every variety of prescription, I find have been perseveringly used whilst the eyes have gone on from bad to worse. It is with granulations of the lids as with many other affections of the eye, namely, that they do not tend to get well of themselves, but are amenable to proper treatment.

Purulent Ophthalmia,

Called also Egyptian ophthalmia, contagious ophthalmia, military ophthalmia. This disease so dangerous for the eyes commences, and is at first like an acute attack of cold in the eye, but goes rapidly on to a much worse condition, the lids becoming greatly swollen, and the secretion of a yellow matter constantly exuding from between them. The corneæ break down with ulceration, slough off, and the eyeball is totally destroyed. How many persons have thus been blinded in a few days, whom active and early treatment would have saved from this misfortune! All I can recommend to be done till surgical assistance can be obtained, is the utmost cleanliness by washing out the eyes, as I described with the same trouble in new-born infants. The minutest speck of the secretion coming in contact with the sound eye of another person, will excite the same disease in it, and thus it is spread through barracks or armies as a fearful scourge. Isolation of the cases, absolute cleanliness, careful destruction of all rags, etc., are indespensable, of course, and the best care and attention on the part of the surgeon, who not infrequently has fallen a victim to his devotion to his patients.

Pterygerium.

I am obliged to use this professional name, as there is no common one in English. I mean a little fleshy-looking growth coming up generally from the inside of the eye in a triangular form, and encroaching on the cornea. It very rarely grows half-way over the transparent part of the eye in front. When of any size, it produces some irritation, and patients are most always afraid it will grow over and cover the sight of the eye. This almost never occurs. The old operation for removing this fleshy growth did not prevent its recurrence. Nowadays we strangle it, or transplant it below the cornea, where it either withers away or does no harm.

Disease of the Membranes within the Globe.

Very few of the diseases of the internal parts of the eyeball present, externally, any indication of their presence. Varying degrees of pain, intolerance of light, and dimness of vision, up to total blindness, are all the symptoms the ophthalmic surgeon formerly had to guide his treatment, till the invention of the ophthalmoscope, by Prof. Helmholz, revolutionized ophthalmology, or the study of the diseases of the eye, by allowing us, through this instrument, to see perfectly the interior of the eyeball, and tell exactly what disease exists, in what membrane, whether in the crystalline lens, the vitreous humor, the optic nerve, the retina, or the choroid coat, etc.

Of course, therefore, it is useless to speak here of these diseases, which the ophthalmic surgeon alone can see by means of the ophthalmoscope, and understands how to treat. Some forms of the diseases of the membranes within the globe are not amenable to treatment, are not curable. Before we could see just what they were, the unfortunate patients were naturally subjected to all sorts of treatment; of course, perfectly useless, and sometimes very hurtful both to the eye and general system. For instance, there is a form of blindness which begins to show itself as dimness of vision, mistaken for near-sightedness, in childhood, and goes steadily on to total blindness at about forty-five years of age. The eye exhibits no external symptom, but the ophthalmoscope shows a most remarkable deposit of pigment in the retina, which tells the ophthalmic surgeon at a glance what the trouble is, and he knows nothing can be done. About one-third of such cases have been found to occur in the children of parents related to each other; first cousins, for instance. It certainly argues directly against such consanguineous marriages, distinct from many other reasons, equally convincing. Blind relatives, undoubtedly, run great risk in marrying.

Amaurosis.

This word was formerly used to denote about all the diseases of the eye where, as has been wittily said, the patient saw nothing, and the surgeon also. The ophthalmoscope, by revealing to us the interior of the eye, and hence the causes of almost all blindness, enables us to distinguish between one and another; for instance, between the blindness acompanying Bright's disease of the kidneys and diabetes, between several forms of disease of the optic nerve and the blindness caused by diseases in the brain, some of which latter are directly found out by the ophthalmoscope. Hence it is, that the word, as used by ophthalmic surgeons, no longer expresses a disease, but simply means the patient is blind, generally from some cerebral cause. It is, however, a word popularized by quack oculists and advertising charlatans, who tell their applicants that they have *amaurosis*, as if it was a distinct disease, and that they will cure them for so much money paid down, or so much a month.

Watery Eye.

The tears pass from between the eyelids, through two little canals in the inner angle of the lids, to a sack at the root of the nose, and from there, through a canal, to the nostril. This, as will be seen, is quite a long and circuitous route. If, in any part of it, there is trouble enough to stop up the canal or passages, then the tears escape from between the lids and run over the cheek, producing great annoyance, and finally serious disturbance of vision, and probably drawing down of the lids, and misplacement of the hairs on their edges. The collecting of the tears in the tear sack, at the root of the nose, causes it to inflame and produce a very painful abscess, which, when it bursts on the cheek near the eye, results in a permanent fistula, through which the tears constantly flow, and render the patient perpetually miserable, not to speak of the uncomfortable appearance of such a face.

The various methods of treatment I shall not, of course, attempt to describe here, as they would not be understood, and can only be carried out by the ophthalmic surgeon, who, as well as the patient, must have patience and perseverance with these cases which are the most difficult to cure. I am glad, however, to be able to state that modern surgery has greatly reduced the painfulness of the necessary operations, and much limited their extent and number. My readers will notice much fewer people going about now with the head of a pin exposed on the cheek, near the eye, the upper end of the old-fashioned style.

Styes on the Lids.

These should not be poulticed, but kept anointed with some simple fatty substance, constantly bathed with *hot* water, and opened freely as soon as ripe. One after the other occurring shows some disturbance of the general system, requiring appropriate constitutional treatment.

Ingrowing Eyelashes.

These come from many causes, principally the drawing in of the lids from burns, inflammation, granular lids, etc. To pluck out the hairs, no matter how carefully it is done, is but a temporary and uncertain relief. The irritation they produce not unfrequently destroys the eyeball, and very frequently causes more or less blindness, from gradual opacity of the cornea. The operations invented by modern surgery for these troubles have met with very brilliant results, when carried out by competent surgeons. The immediate relief from an appropriate operation on the lids is wonderful. The eyelashes need not always be sacrificed, but frequently can be retained as natural.

Tumors of the Eyelids.

These are of very frequent occurrence, as little knots or bunches, harmless unless they increase in size or inflame, when they should be removed, by an operation which is by no means a simple one, since such growths generally involve the whole thickness of the lids.

Use of the Eyes.—Protection and Protectors.

Common sense and their sensations must govern my readers in regard to the use of the eyes. An Argand gas-burner with a blue chimney, petroleum or oil lamps, moderators, etc., are all good enough lights, if we have *enough light* from them coming in the right direction. All light on our work, whether artificial or sunlight, should come from one side, and not be reflected by the paper or book before us into the eye. When the eyes are *weak* there is a *reason* for it, and good advice should be sought at once. Don't try to find this from advertising quack oculists, or travelling spectacle sellers. All sorts of goggles are, as a general thing, hurtful to the eyes, and never should be bought or worn without advice. Smoked glasses, and green, do not give the needed protection, ease, or rest to the eye. The proper color is cobalt blue. All spectacle glasses are now manufactured of several shades of this color, which has a definite effect on the sun's spectrum, and alters the character of the light which comes to the retina, thereby stimulating it to give us what we call sight. This fact has but recently been discovered, and hence it is that one sees so many people going about with blue glasses. These are of great assistance in curing some affections of the eye. Of course these blue glasses also are now advertised, and hawked about successfully, because the purchaser finds them comfortable, and therefore buys them at four or five times their value. The special shade of blue which should be worn, must be decided by each individual case, by the surgeon, and not by the buyer or seller.

TEST TYPES

FOR ASCERTAINING THE POWER OF VISION AND SELECTING SPECTACLES.

Any one with normal eyes should be able to read the following, at the several distances indicated:

No. 1. 14 *inches.*

I have in previous articles warned my readers against purchasing spectacles for themselves without proper advice, although, no doubt, it is a good thing for those who sell glasses, as thus their customers will have to buy several different pairs before they pethaps stumble on the right ones at last. I have, also, explained near-sightedness, over-sightedness, and old sight, and, by diagrams, shown the reason for the use of glasses and their effect, and that there was another optical defect of the eye, called astigmatism, which it required peculiar glasses to overcome, but which, when thus overcome, enabled the person to see as he never had before. It is a great misfortune that spectacles, generally of the most inferior quality, especially as to the frames, should be sold in every jeweller's shop or clockmaker's, and hawked about on the village streets. That the community may learn better than to puchase such is the object of this article. Amongst the best opticians of the larger cities of the United States a few have learned something about the proper selection of glasses, and, if they

No. 2. 19 *inches.*

are honest, at once advise their clients to apply to some scientific ophthalmic surgeon, unless they are easily and readily fitted. The amount of harm done by the enormous sale of spectacles, of all kinds, by means of quack doctors, handbills, and advertisements, is very great. So, also, the advertisements of the spectacle vendors would make one believe that a pair of spectacles meant a pair of new eyes. Now, first, as to near-sightedness. This may be congenital, and remain the same through life, the eyes bearing constant, and almost unlimited, use. But near-sightedness, when increasing, may also be a symptom of disease of a severe and dangerous form, so far as sight is concerned. Every case, therefore, requires to be examined for itself, and the proper glass selected. No optician or spectacle seller can do this, any more than an apothecary can prescribe for a severe

No. 4. 33 *inches.*

disease. Over-sightedness is a cause of squint and a very frequent trouble with the eye. People are born with it, as it is due to the natural shape of the eye. It does not produce trouble till the eyes are called upon for great work, as in school or college, and then the proper glasses must be worn. Often a child or young person requires exactly such glasses as their old parents or relatives wear. But this horrifies the latter, and the poor patient is deprived of the glasses which will save his eyes from ruin. This the community are naturally very slow to learn. Old sight commences at from forty to forty-five years of age—that is, at that time of life, not the power of sight, but

No. 6. 38 *inches.*

the effort the eye has to make to see fine objects, begins to fail. It has failed from about ten years of age, but we only require it to be corrected by glasses when it prevents our ordinary occupations of reading, writing, and sewing. It will keep on failing, and we shall therefore require stronger and stronger glasses. Every case is one by itself; but where the eyes are normal and sight good, and only failing from age, the table to be found in the article on this subject gives the glass required at each age. This, of

No. 8. $4\frac{1}{2}$ *feet.*

course, is only approximately. Glasses at first only worn at night must afterwards be worn in the day-time, and stronger at night, and so on. They must be carefully selected by an ophthalmic surgeon, who alone is capable of choosing what should be worn. The several different sizes of print in which this advice is given, correspond pretty

No. 11. $5\frac{1}{2}$ *feet.*

nearly to the test types you will find the ophthalmic surgeon has to test your eyes with, if you apply to him. Whoever can read the finest fluently at twelve inches distance, with either eye, has good sight. If they cannot read it thus,

No. 12. $6\frac{3}{4}$ *feet.*

their sight is not normal, and the longer they neglect their eyes the more will they finally regret it. Astigmatism is the name given to another form of trouble with the eye, due to the natural shape of the eye-

No. 14. 10 *feet.*

ball not being perfect. It generally counterfeits near sightedness, and people are made very

No. 15. $13\frac{1}{2}$ *feet.*

happy to find that, with the right glasses, they can see as others do. The se-

No. 16. 17½ *feet.*

lection of the proper glasses, how-ever, is by no means an easy thing, even for the ophthalmic surgeon.

No. 17. 24 *feet.*

Opticians, and people who sell spectacles, are

No. 18. 30 *feet.*

quite incapable

No. 19. 37 *feet.*

# of doing it.

THE EYE
IN HEALTH AND DISEASE