THE A B C

OF

FITTING GLASSES.

A MANUAL FOR THE OPTICIAN.

BY

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THE FITTING OF GLASSES.

To be successful in any undertaking in life we should be methodical and painstaking in every detail of our work. From the experience of years I have found that many things seemingly of little importance are after all valuable. These as well as the major ideas will be noted as we pass along.

First.—*Keep a record book.* Do not trust your memory, however good it may be. You cannot show your memory to others, neither can you always retain in mind the various points of interest regarding your patrons. One page should be devoted to each case, and your book at its close should be so indexed that you can refer in a moment to anything it contains.

Second.—*Record the date, name, age, address, sponsor and origin* of each case. The date of each treatment is necessary so that if any question arises as to any item of your bill by turning to your book you can show the very time at which it was incurred. The writing of the name in your book gives you an opportunity to ask it of a stranger and thus aid you in forming his acquaintance. The age is of value in helping you to determine how full a prescription to make for hypermetropia or presbyopia. It will also assist you in recalling the case of any person who writes you after a year's absence regarding his glasses. Very few people will

object to giving you their age, and even if they should you can approximate it, but always guess over rather than under if required to resort to speculation on the subject.

The address is required in case you need to send the glasses or present a bill, and the sponsor, in case the patient is under age. It is always a satisfaction to know how you got a case, and it is a polite thing to acknowledge the courtesy if the patient is sent by some physician or business friend.

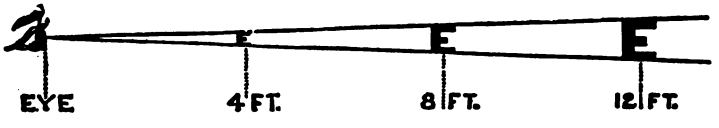
Third.—*Write a full history of the case.* By doing this the first time he comes you can note any improvement in the symptoms after the patient has worn the glasses. Sometimes you will have patients who are always complaining. No matter what you do for them they are "no better." By referring to their history you ask regarding each specific symptom, many of which have probably disappeared and been forgotten by the patient. You will thus be enabled to convince them that they are better, and mental suggestions of this variety are a great aid in really curing your cases.

Fourth.—*Note all peculiar or diseased appearances as you look the case over*, you will thus have a criterion of improvement or the reverse as the result of your work.

Fifth.—*Test the vision of each eye separately, the other being covered.* To do this you should have your test type hung in a good light twenty feet from your patient who is seated in a comfortable chair protected from sun and drafts and from the curious gaze of bystanders. The record of each eye should be kept, for often there is a marked disparity in the visual power of the two eyes. Again, unless you keep an accurate record of the vision at the time you begin to treat the case you

will have nothing to answer those complaining individuals of whom we have before spoken. Near-sighted people, as a rule, think they have excellent vision, and after they have worn glasses for a time they come to realize that without glasses they do not see well, hence they frequently aver that the glasses have ruined their former good sight. By retesting them without glasses you can demonstrate that their vision is the same or even better than it was when you commenced treatment.

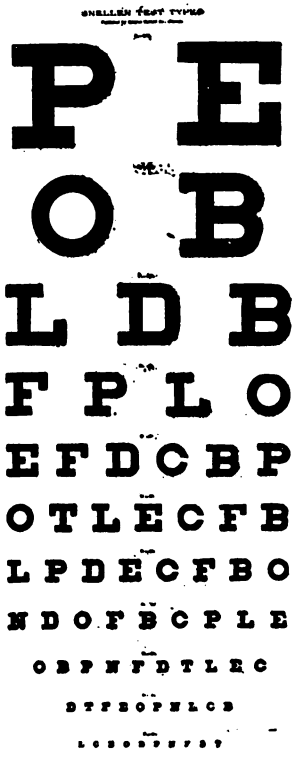
Sixth.—*Record vision* by a common fraction of which the numerator is the number of feet from the patient to the test type, and the denominator is the line of type read. The distance should be, if possible, 20 feet. If at this point they cannot see the line marked "D—200" have them approach the type card until they can see the line "D—200." The distance, in feet becomes the numerator and 200 the denominator of the fraction. No matter if they declare that they only want reading glasses, test for distance first and explain to the patient that in order to fit accurately for the near point and to give the best permanent satisfaction it is necessary to find what their distant vision is first. The letters on Snellen's test cards are made on such



a scale that when seen at a distance indicated above the line each letter subtends an angle of five minutes (5′) the average of normal eyes. If the letters which should be seen at 40 feet can only be read at 20 feet, the vision is but one-half as acute as it should be.

Seventh.—Record the best vision you can give to each eye and the strength and nature of the glass with which this result is attained. The intermediate step by which you arrive at your decision need not be set down.

Eighth.—*Record the results of your ophthalmoscopic examination.* This should always be made if you would be a scientific observer. By it you may detect the presence of cataract, corneal opacity, mobility of the pupil, diseases of the fundus (back) of the eye, and even in some cases the presence of disease of the brain and kidneys.



Ninth.—*Record the absolute refraction.* This may be arrived at by means of atropine instilled into the eye or by the ophthalmoscope, or by higher prisms as explained later.

Tenth.—*Record your prescription* in all its details, both as to lenses and frames, so that if the patient loses his glasses and writes to you to duplicate them you will have no trouble in doing so.

Eleventh.—*Record what you think it will be best to prescribe at the patient's next visit* For example, if you are developing a latent heterophoria along any given line, while the case is fresh in your mind, or after you have studied it carefully, if you

fail to write down your conclusions you may be compelled to go all over your work again, and this saving of time is often valuable.

Twelfth.—*Test carefully for manifest heteraphoria and record the results.* True, the error may be a reverse manifestation, but it should be recorded for the sake of future reference and comparison, so that you can note the changes produced by your treatment. Also record the *fusion power* of the two eyes at a distance.

Thirteenth.—*Keep an exact record of all charges, receipts, cost, etc.* The latter should be in cypher, so that you can show the account to the patient if any dispute arises. Having all this on a single page enables you at a glance to refresh your memory, and to decide from past experience whether you can afford to trust a case with further credits.

HYPERMETROPIA.

Hypermetropia (*hyper* in excess; *metron*, measure; *'ops*, eye;) is that condition of the eye in which rays of light from distant objects are brought to a focus, behind the retina, the eye being at rest. This condition gives rise to true or accommodative asthenopia (weak sight) since the eyes when once they have become exhausted cannot be used continuously for near vision even in the best light without pain and confusion of sight, although for the first moments the patient can see easily and distinctly.

The optical defect is that the antero-posterior diameter of the ball is too short, or the refractive power is too low, so that, instead of getting clear images upon the retina, the patient perceives everything as confused.

The hypermetrope, therefore, has to use some of his accommodation to see distant objects distinctly, and hence starts with a deficit for all other requirements. To see print at the ordinary distance he requires all the efforts of the emmetropic eye, plus enough more to overcome the amount of his hypermetropia.

The defect is a congenital one, and due to an imperfect development of the eyeball, but is seldom discovered until the child begins to read, or until some exhausting exercise or illness makes it manifest.

In youth the hypermetropic eye is strong, since the constant effort put forth to see, gives the ciliary muscles increased growth and power. But some overuse of the eye, some excessive strain, especially in a period of ill-

health, so weakens it that henceforth it is unequal to the task it has to perform. For this reason we find nearly twice as many cases of weak-sight in hypermetropic eyes among women as among men, not because more of them are hypermetropic, but because they are weaker physically, their hours of work are more, and their occupation, especially by artificial light, requires greater exertion of their power of accommodation. Men naturally endowed with great power of accommodation may escape asthenopia altogether. Thus, the American Indians are almost universally hypermetropic and yet they are possessed of the keenest sight and the strongest eyes. A physician of this city, well along in years, having a hypermetropia of high degree, is yet able to see very fine print close to his face. Among men we find the most cases of true asthenopia in students, clerks, book-keepers and professional gentlemen, who use their eyes constantly for near work.

While far-sightedness resembles old-sightedness (presbyopia) in many of its symptoms, the two must not be confounded. The former is due to the shape of the globe, the latter to a gradual loss of power of the accommodation. The former exists in childhood and continues through life. The latter only exists as the result of age. Both, however, are relieved by convex glasses.

Etiology. The causes of hypermetropia are :

1. Heredity. Several members of the family being usually affected.

2. The result of disease, the cornea having become flattened.

3. Absence of the lens, as after cataract operation.

4. Detachment of the retina, from tumor or exudation behind it.

5. Reduction in the power of refraction of the lens.

History and Diagnosis. The onset of the trouble is at first gradual. The eyes become tired more or less easily. The lids are irritable. Headaches are common. The remedy is at first neglected, as such people object to being laughed at by the ignorant for "wearing glasses so young." Hence the patient continues to overuse and strain his eye, determined to accomplish given amounts of work in given times, until there comes a day in which his eyes suddenly give out. He "cannot see." The letters are blurred. He has moments of blindness, and in alarm he bethinks himself of the oculist he should have consulted long ago.

Symptoms. The patient states to you that he can see distant objects very well, but that after reading a little while, the print becomes indistinct and the letters run together; the eyes ache and fill with tears, and there is such a feeling of discomfort that he must rest them for a time. The symptoms then quickly subside, but reappear when work is resumed. If relief is not given, the eyes become bloodshot, and upon the least service are fatigued and painful, so that they can scarcely be kept open, and the lids are apt to adhere in the morning. In other cases reading may, invariably, be followed by such headaches that cerebral trouble is apprehended, and the patient is condemned to spend her time in idleness, when the whole trouble might be removed by correcting the hypermetropia with suitable glasses.

If young, the patient's friends may think him short-sighted because he holds the book close to his face. This is owing to a spasm of the ciliary muscle, which produces a temporary myopia. This condition is exceedingly common, and opticians must always be on their

guard against it. Such a patient selecting glasses for himself would choose concaves, and thus bring on a confirmed myopia, whereas he ought to have the spasm relaxed, and wear convex lenses.

Objective Signs. Frequently a flat-looking face, with eyes small, and seemingly far apart, are indications of hypermetropia. The lids look irritable, and may even become granular from this cause alone. Hence, in all chronic ophthalmic troubles the refraction should be tested, as frequently complaints which have been intractable are easily and quickly cured when the proper glasses have been prescribed. The pupils are large and sluggish, in cases accompanied with irritation or disturbances of the uterine or digestive functions. Convergent squint in a child is an almost certain sign of hypermetropia.

Test Type. The manner in which the patient reads the type at twenty feet is often an indication of the trouble. It takes some time for him to make out each line, but if not hurried, he reads it all correctly. If, however, the degree of error be high, or there is much spasm of the ciliary muscle, he may fail to read No. XX at twenty feet. Except in this last condition a weak convex glass before the eye aids his vision, and the glass with which he sees best is the measure of his manifest hypermetropia. Owing to the tonic contraction of the ciliary muscle, some hypermetropia is usually concealed. As age advances, however, this also becomes manifest.

To discover the entire error of refraction in young people and children, it is necessary to relax the ciliary muscles with atropine. By this, also, we are able to diagnose a spasm of the muscle in hypermetropia from the stimulated myopia. Under 35 years of age

no harm need be feared at the hands of an experienced physician, a 4-grain solution being used three times a day for three days. Above the age mentioned it is seldom necessary to use a mydriatic. Repression with strong convex lenses will accomplish even more than atropine.

Pin-Hole Test. This simple test may be used when the proper convex and concave trial lenses are not at hand. The patient is to look through a large pin-hole in a blackened card at a light twenty feet away. Vision is at once improved. When the card is moved rapidly before the eye the light seems to dance. If two holes are made an eighth of an inch apart he sees two lights, "the second at the left of the other."

Ophthalmoscopic Test. The patient's accommodation having been paralyzed, and your own entirely relaxed, find the strongest convex glass in your ophthalmoscope, with which you can clearly see the vessels and nerve. This is approximately the measure of his total hypermetropia.

By retinoscopy the shadow moves against the mirror. The greater the error of refraction, the slower the movement and the less distinct the outline. As it is often important to find the exact error in cross-eyed children too young to read, this method gives it to us very easily and perfectly.

Treatment. The primary and most important indication in the treatment of hypermetropia is the selection of the proper convex lenses, which should be prescribed on the first appearance of asthenopic symptoms. These obviously relieve the strain on the ciliary muscle, since they produce the same effect upon the eye as increased accommodation; i. e., they adapt the eye for nearer

vision, allowing it easily to bring divergent rays of light to a focus upon the retina.

One might, at first, suppose that the proper glasses would be those which would exactly correct the error present; but this is far from the case, since the eyes are unable to at once accustom themselves to so great a change of refraction. People selecting spectacles for themselves generally choose those which are too strong. Even the most experienced oculists sometimes have "considerable trouble in finding glasses which can be worn with comfort; and yet, if the eyes are to be used at all, the help of glasses is absolutely required." (Angell.) Again, so many cases are complicated with astigmatism that it is unsafe for any one except an oculist or expert optician to risk a prescription.

If the hypermetropia is of a high degree, it may be necessary to begin with weak glasses and increase the strength every few weeks in order to effect a perfect cure.

For young people, it is best to prescribe for reading only, since, if glasses are worn constantly, they become indispensable. Nevertheless, there are cases in very young children, possessed of marked hypermetropia, where we should insist upon their constant use in order to avert the change of myopia, which often occurs as the child begins to read; and again, if the eyes are crossed, the patient should wear glasses all of the time.

Aged people, with much hypermetropia, and those who have endured the operation for cataract, must have two pair of glasses, one for distance, and the other a stronger pair, for near vision. In uncomplicated cases, eye-glasses may be used.

Regimen.—Certain cases, in which the error of refraction is slight, and the trouble has been brought on by general debility, it may be relieved without the use of spectacles by restoring the patient to vigorous health through a change of air, a generous diet and the proper internal medication, but even in these cases plus lenses associated with higher prisms will much more quickly restore health.

In all cases of asthenopia, work should be interrupted every half hour to rest the eyes and enable them to resume with vigor and ease. In obstinate cases "it may be necessary to completely paralyze the accommodation for some weeks by the instillation of atropine, simply for the purpose of resting the eyes." If, under the use of plus glasses, all symptoms of asthenopia do not disappear, the fault probably lies in the power of convergence, (muscular asthenopia).

Medicinally, we may often greatly benefit our patients by the use of macrotin, nux vomica, spigelia, or gelseminum. If retinal hyperaemia coexist, cactus or belladonna may be called for. Irritability from over use is relieved by jaborandi; and ruta may be of service in restoring the strained *musculus ciliaris* to its normal tone.

Prognosis.—By the proper treatment, attended to early, we may hope for the most favorable results; otherwise the following sequelae often occur:

1. Convergent strabismus. 2. Spasm of the ciliary muscle. 3. Myopia. 4. Disease.

First.—Convergent Strabismus (cross-eye) is very frequently due to hypermetropia, at least 80 per cent of all cases being traceable to it. The trouble may, however, be checked in its very beginning, at the age of

three or four years, by paralyzing the accommodation for a length of time, and the using of proper spectacles.

Second. Spasm of the ciliary muscle is more often found in slight hypermetropia than in that of high degree. It causes dread of light (photophobia), watering at the eyes (lachrymation), pain, contracted pupil and hyperaemia of the retina. Its treatment consists in paralyzing the muscle by "the methodical use of atropine (gr. iv to the ounce) applied two or three times, daily, until the accommodation is quite relaxed. It sometimes yields in a few hours, in other cases not for several days." Glasses must be immediately applied that the patient may become accustomed to them while the effect of the atropine is wearing off, as otherwise the spasm will return. By repression with higher prisms the same results may be obtained. If the refraction is not corrected this spasm of the ciliary muscle will change a hypermetropic to a myopic eye.

Third.—Many children who are hypermetropic at birth, become myopic when they begin to use their eyes continuously for reading, sewing or fine work. (Angell.) This is especially apt to be the case if the child is not robust.

Fourth.—Hypermetropia, when combined with astigmatism tends to produce certain morbid changes in the fundus like those which occur in myopia. Nearly three-fourths of all cases of that dreaded affection, glaucoma, which so often results in blindness, occur in hypermetropic eyes. Other diseases of a nervous character, as neuralgia, insanity, diabetes, asthma and even consumption, often originate from and are always aggravated by hypermetropia and are often cured by proper plus lenses associated with higher prisms.

CORRECTION OF HYPERMETROPIA.

Having tested the vision we proceed to correct any errors of refraction which may be present. It is well to begin with the right eye unless our test of vision has shown us that the left eye sees very much better than the right. The object in so doing is that we may be methodical. If, however, the left vision is much better we begin with that eye because any anomalies of the better eye will probably be found exaggerated in the poorer; also because the defective vision of the poorer eye may be due to some opacity in its transparent media, or to an amblyopia (defective vision without visible cause) of the retina.

The other eye then being covered with an opaque disc (preferably black, metallic) we begin by placing in the trial frames *convex spherical lenses.* This is done because the most common error is one of hypermetropia, and also in order to prevent the exercise of the accommodation. If we had a hypermetropic eye and should begin with a weak myopic sphere, the eye would adjust itself to the glass by using its accommodation, and if this process were followed out, stronger and stronger minus lenses being added, a spasm of accommodation would occur which would entirely conceal the true condition of the eye. This is one thing we must always avoid. It is true that minus glasses often seem to improve vision temporarily even in strong hypermetropic eyes, and a great many spectacle venders will give that glass with which their customer sees best,

thereby often doing irreparable damage, not only to the eyes, but to the entire nervous system as well.

A case of this kind came to me the other day. It was a lady suffering with complete nervous prostration. She had been "fitted" with glasses in San Diego, Cal., but said that while she could see better with them, they made her very nervous every time she put them on.

The strength of the initial glass should depend somewhat upon the amount of vision; for example, if without anything before the eye it can read $\frac{20}{30}$ or even $\frac{20}{20}$ it is well to begin with a weak sphere of we will say, + .25 or + .50 dioptre. If this glass improves the vision, increase the strength to + .75 or to + 1. and make a record of that glass with which the vision is best. After you have past the point of most acute vision the addition of still stronger plus spheres will impair or "fog" the sight.

Sometimes it is difficult for the patient to determine with which glass he does see best. In such a case leave one glass in the trial frame and place over it a + 25 or + .50 for a moment and then remove it, repeating the process until the patient can determine whether he sees better with the combination or with a single sphere. If the former, we simply add the strength of the two glasses, thus determining the dioptric power of the required lens.

If the vision is very poor without any glass, as $\frac{20}{80}$ or $\frac{20}{200}$, we may begin with + 1. or + 2. dioptre, for there may be a very high degree of manifest hypermetropia, in which case a weak plus sphere would not appreciably benefit the vision. Some authorities urge that we should always begin with a strong plus sphere and work downward in order to prevent any spasm of accomodation.

It is often found, however, that in young people, a real spasm of accommodation is not to be relaxed by any such method.

If vision can be made perfect, i. e., $\frac{20}{20}$ or $\frac{20}{15}$, with a plus sphere, having determined the required strength of the glass to produce this result, we still add plus spheres in order to find out the strongest glass with which vision is still $\frac{20}{20}$; for wherever there is some manifest hypermetropia there is usually considerable latent hypermetropia, and it is well, in many cases, to prescribe the strongest plus glass with which the patient can possibly see $\frac{20}{20}$. In higher prisms we even go beyond this.

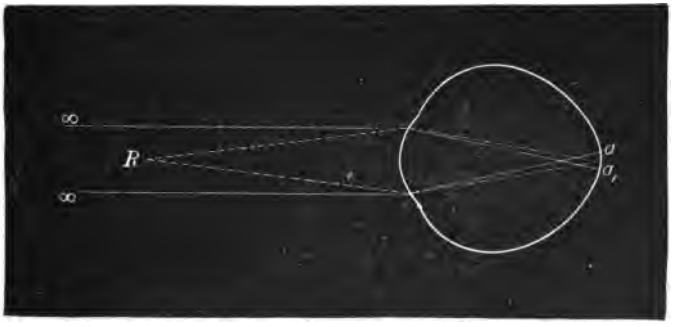
The opaque disc should now be changed so as to cover the eye first tested, and the same method should be pursued in examining the other eye.

Having fitted each eye separately we try them together, and unless there is a great disparity in the strength of the two lenses, vision will be better and easier with both eyes than with either alone. If, however, one eye requires a much stronger lens than the other, we frequently find it necessary to equalize the disparity somewhat by giving the strongest lens that the better eye can wear and placing before the other eye the strongest lens which is at all comfortable, even though it does not bring its vision up to the standard.

MYOPIA

Myopia is a condition of the eye in which it is impossible to see distant objects clearly. An eye so affected is sometimes called a microscopic eye, vs. the telescopic, as in hypermetropia.

Myopia is classed under false or accommodative asthenopia, since the weakness is due to inability to relax the



Path of the Rays in a Myopic Eye.

accommodation for distance. Parallel rays (those coming from a distance) are focused in front of the retina, thus causing the image formed to be confused and indistinct.

The optical defect is, that the eye-ball is too long from before back, due to its bulging posteriorily at the entrance of the optic nerve.*

This anomaly requires especial and considerate attention, as "its tendency is constantly to progress, until it

*Diseases of the eye, Angell, p. 58, Id.; Wells, p. 629. Ophthalmic Science and Practice; Juler, p. 346, Refraction of the Eye; Hartridge, p. 22.

may terminate in complete blindness."† The myopic eye is always a diseased eye. (Hartridge).

Myopia occurs but rarely in infancy or among the illiterate, while with savage races it is almost unknown. The disease developes in childhood and adolescence, as the eyes are used for near work, and, according to German ophthalmologists, increases in direct proportion to the amount of education.¶

Etiology.—(Causes) 1. Myopia is rarely congenital, but the tendency to it is often hereditary.§

2. It is generally due to the prolonged and close application of an individual to work of a very fine character, which causes congestion of the tunics of the eye-ball and their consequent weakness.

3. The strong convergence of the eyes for near work, and the resulting pressure upon them by the tendons of the *external recti* muscles causes the eye-ball to bulge posteriorily—(Wells). Hartridge says: "Watchmakers and jewelers, who use but one eye, are seldom affected, proving that close work without convergence does not produce myopia." This is true providing a strong lens is used.

4. The stooping position which myopes assume increases the chronic congestion of the eye tunics, resulting in further softening and still further bulging of the posterior pole.‡

5. Work in a defective light, which necessitates the holding of the book close to the eyes.‖

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†Ophthalmic Therapeutics: Norton, p. 311.

¶Vide Dr. Cohn's "Untersuchung der Augen von zehn Tousen und sechzig Schulkindern."

§Diseases of the Eye; Wells, p. 629.

‡Diseases of the Eye; Angell, p. 63.

‖Ophthalmic Science and Practice; Juler, p. 349.

6. Overuse of the eyes in youth when the tissues are yielding.

7. Spasm of the ciliary muscle in hypermetropia with heteraphoria. This is *the* great cause. Many cases of apparent myopia are really not such; but neglected, they become myopia in time.

8. Cloudiness of cornea.

9. Lamellar cataract.

10. Too strong myoptic glasses.

Diagnosis.—The patient finds it difficult to see well at a distance; he may be unable to recognize people across the street; the child at school cannot read what is written on the blackboard; yet both see well enough if the object is near at hand.

There is liable to be pain and fatigue, with intolerance of light, and after prolonged use, especially in the evening, the eyes become irritable, red and hot. Vision, too, is apt to be interfered with by "musicae volitanes" (floating specks before the eyes), or by fixed scotomata (dark spots.)

Objective Signs.—The lids, which are held nearly closed, to diminish the circle of diffusion (whence the name myopia from *muo*, I close, and *ops*, the eye,) are generally found congested. The eyes themselves are usually prominent, and the pupils, especially in young people, quite large. The patient leans over his work, and holds his book close to his eyes.

With the ophthalmoscope, of which, in this enlightened age, every scientific physician and optician should be master,* the appearances are quite characteristic. The

*"In the whole history of medicine there is no more beautiful episode than the invention of the ophthalmoscope and physiology has few greater triumphs. With it, it is like walking into nature's laboratory and 'seeing the infinite in action,' since by its means we are enabled to look upon the only nerve in the whole body, which

fundus is hyperaemic, and white spots of choroidal atrophy are seen, one of which is cresenetic-shaped and lies on the outer side of the optic nerve disc.

Tests. With the ophthalmoscope we can see the details of the fundus at some distance from the eye, if the degree of myopia be at all great. When regarding the optic disc, if we move our head slightly to one side we notice that the image moves in the contrary direction † If we bring the instrument close to the eye, the weakest concave glass with which we see the fundus clearly is the measure of the myopia,¶ the accommodation being at rest.

By retinoscopy, or "the shadow test," the image moves with the mirror. The great advantage of this method over all others is, that by it the refraction of little children and the illiterate can be tested more accurately, and defects detected, which no other test reveals. It is so simple, too, that any one can master it in a very short time.*

Placing the patient with his back to the light, which is two inches higher than his head, and taking your station four feet in front of him, have him look slightly to your right as you examine his right eye, and *vice versa.* Looking through the hole in your ophthalmoscope, as you

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can ever lie open to our inspection under physiological conditions, and to follow in a transparent membrane, an isolated circulation from its entrance into the eye through the arteries, to its exit in the veins We are further enabled to watch and study, daily, morbid processes in every phase, from simple hyperaemia to absolute stasis; while oftentimes, through its agency also, we get the first intimation of disease in remote and seemingly unconnected organs, so as to read, as if in a book, 'the written troubles of the brain,' the heart, the spleen, the kidneys, and the spine. * * * Nor is it surprising that the student, once entered upon its investigation, finds the study as fascinating as it can be made profound."—Loring's Ophthalmoscopy, p. 1. D. Appleton & Co.

† Diseases of the Eye; Wells, p. 633.

¶ Refraction of the Eye; Hartridge, p. 133.

* See Hartridge's admirable article on Retinoscopy (Chap. iv., Refraction of the Eye); also one by Dr. Jackson, in the American Journal of Medical Sciences (Philadelphia) for April, 1885.

reflect the light into his eye, you will perceive the red fundus reflex. As you now rotate the instrument very slightly you will see a shadow come out from behind the iris and partly cross the pupillary space. If this shadow moves with the mirror, or in the same direction that the reflected light on the face moves, the case is one of apparent myopia. If the shadow is well defined, and moves slowly against the mirror, hypermetropia, is indicated. If the shadow moves obliquely, or if, instead of a solid shadow, dark and light lines cross the pupillary space, astigmatism is proved to exist.

With the test type each eye should be examined separately, the other being covered, as often a great difference exists between the two eyes. The myopic eye can never read No. XX at twenty feet, but, as a rule, can read even diamond type if held close to the eye. Distant vision is improved by concave lenses.

Myopia is very often simulated by spasm of the ciliary muscles in a hypermetropic eye, and unless atropine has been used, the tests above given may not detect it. But, as the treatment depends entirely upon the cause of the asthenopia, an error in diagnosis might lead to grave results, so that it may be convenient, in children and young people whom you can see but once or twice, to thoroughly paralyze the ciliary muscle with atropine, when the fault can generally be discovered. But even this may fail, and it is better to resort to higher prisms at the very outset, and thus avoid the possibility of a mistake.

Treatment.—The aim in the treatment of myopia is five-fold:

1. To prevent its onset.
2. To prevent its increase.

3. By suitable glasses to enable the patient to see at a greater distance.

4. To remove any muscular asthenopia.

5. To combat secondary disturbances.

First.—We cannot impress too forcibly upon all who have to do with the education of the young, the importance of preventing myopia, by removing all conditions which are likely to cause it; and it is the duty of physicians everywhere to enlighten parents and teachers as to the fatal defects in school-room furniture. The seats and desks should be so arranged that no stooping is necessary, or even possible, but the children be compelled to sit erect and hold their books high. The light should be good, but never facing the pupils.* Children should not be allowed to read too much in the evening, especially by a weak light. When in poor health, after passing through the measles or scarlet fever, or when affected with any cloudiness of the cornea, increased caution is necessary.

Second.—To carry out the second indication, the prevention of any increase of myopia, patients should be instructed never to read in a moving train or carriage; to avoid all fine work, such as crocheting, at least, temporarily; to use books printed in bold, good type; to write in a large hand, and sit erect when so engaged; to sit so that the light may come in over the left shoulder, and to use artificial light as little as possible; never to hold the book nearer than twelve inches to the face, and always rest the eyes as soon as they become tired. "It is desirable that patients discontinue work and rest their eyes from two to five minutes every half-hour."‡ Pa-

* Vide Juler's Ophthalmic Science and Practice, p. 351, and Angell's Diseases of the Eye, p. 77.

‡ Ophthalmic Therapeutics; Norton, p. 311.

tients should exercise daily in the open air, and practice looking at distant objects. In school-children it is often necessary to take them out of school for a year, when the disease is found to have been arrested.

Third.—The correct prescription of glasses for myopia is a delicate matter, and requires an exact knowledge of the intra-ocular conditions present. Patients, if left to choose for themselves, always select glasses which are too strong; and there is nothing which so rapidly increases an existing near-sightedness as the use of such improper lenses.¶ Patients, therefore, should never buy their spectacles at random, of dealers or itinerent vendors, but should always have them accurately prescribed by a competent oculist or optician. The evil result of random spectacle-buying may be seen in Dr. Cohn's report of 1,004 near-sighted children in the German gymnasia, where only 107 wore glasses at all. Of these, 99 had selected their own, "and 11, only, were those which were not injurious to the eyes."

Today a lady came to me suffering with inflammation of the optic nerve and retina, induced with glasses she had chosen for herself, and which were two dioptrics too strong. She also had astigmatism, which, of course, her glasses entirely failed to correct.

Frequently myopic glasses are not needed at all; but if found necessary, we give the weakest concave lenses, which remove unpleasant symptoms and render distant vision easy, though not usually perfect.

Glasses are often prescribed for certain distances—as two feet, for reading music. In high degrees of myopia, two pairs may be employed, one for distance and one for nearer work. The patient should be impressed with the

¶ Norton, p. 312; Angell, p. 74.

fact that the glasses that are given him for reading are not to enable him to see better, but "to increase the distance at which near objects may be seen," and thus relieve the eye of the necessity of strong convergence.

Fourth.—For the treatment of the muscular asthenopia, if any, see a later chapter.

Fifth.—To combat the secondary disturbances, great attention must be given to the general health. Regular out-of-door exercise should be taken, and the system built up by suitable diet, hygiene and medicines. Jaborandi, phosphorus, physostigma, ruta and sulphur are often useful. For pain and inflammation, compare belladonna, phosphorus, prunus spin, spigelia and thuja,† cactus and macrotin.§

In case the disease progresses steadily, we must give the eye entire rest by the installation of one grain solution of atropine three times a day for some weeks. Or better still, employ fogging with higher prisms. Often a wash of tepid water and milk is grateful to the eye.

Prognosis (Expected results).—Myopia may (exceptionally) remain stationary from childhood to old age; or it may temporarily progress to the age of thirty, and then stop, if the general health be good; or, again, it may progress steadily and constantly. It was formerly said that it never decreased; that the globe never resumed its normal shape, and that the "far point" could never recede from the eye. The falsity of this theory can be easily demonstrated by the use of higher prisms. Due to the influence of age, the near point does recede, so that we oftentimes find old people who, at sixty, are able to read without glasses. This

† Norton's Ophthalmic Therapeutics, p. 311.
§ Angell's Disease of the Eye, p. 70.

is proof positive that they have myopia,‖ though you would probably be unable to convince them of the fact.

If the near-sightedness is of high degree, amblyopia (poor vision, due to nervous defect) is the invariable result. The patient is greatly troubled with floating specks and black spots in the field of vision. When myopia is progressive from the first, changes take place in the back of the eye, causing inflammation, and sometimes resulting in complete disorganization of the part. These changes are chorodail atrophy, opacitaco and disorganization of the vitreous, intraocular hemorrhage, detachment of the retina, and cataractous condition of the lens.

In youth, almost all myopia is progressive, and "progressive myopia threatens blindness."* It does not always result in blindness, by any means, but it may do so. Hence, we see the necessity of giving early attention to this affection, and making every effort to check its progress.

‖ Hartridge's Refraction of the Eye, p. 124.
* Angell, p. 68.

CORRECTION OF MYOPIA.

Having failed to improve vision with any plus sphere, and finding, on the contrary, that even the weakest convex glass impairs vision, we naturally seek for aid among the concave or minus lenses. But we must do so, knowing that we are treading on dangerous ground. Why dangerous? First, because an hypermetropia associated with spasm of the ciliary muscle stimulates a myopia, and vision in such cases is temporarily improved by minus lenses, but to prescribe such lenses would not only increase the eye-strain and cause many nervous reflexes, but might greatly injure the eyes themselves. Second, a weak minus eye-glass sharpens the outline of distant objects, even to an emmetropic eye, and if the patient be slightly myopic he will choose a stronger minus glass than he ought to wear. Hence, we say that when using minus glasses we are on dangerous ground, and I always advise my classes to beware how they prescribe them.

But the testing with minus glasses and the prescribing of them are two entirely different matters. We will first consider the former. When should we test with them?

First, when the vision is below normal.—A myopic person never has vision equal to $\frac{20}{20}$. Hence, if your patient can read the line XX at twenty feet, you know at once that minus glasses are ruled out, even though he may be able to see much better with them.

Second.—When with the ophthalmoscope, your own refraction being corrected, *you cannot see the light streak*

in the arteries of the retina except by placing a minus glass before your eye. For only in such a case is there any real myopia present.

Method.—Vision being below normal and made worse by any and all plus lenses, and the ophthalmoscope showing a true condition of myopia to exist, you cover one eye with the black disc and place before the other eye *a minus sphere.* The strength of the sphere is to be determined largely by the acuity of vision. If this is $\frac{20}{30}$ or $\frac{20}{40}$ it is well to begin with a —.25 or a —.50 dioptre. If it is only $\frac{20}{100}$ or $\frac{20}{200}$ begin with a —.1. If vision is reduced to $\frac{10}{200}$ or $\frac{5}{200}$ the weak spheres will scarcely influence it at all, and you will have to begin with a —5. or —10. dioptre glass. If the first glass placed before the eye improves vision somewhat, try a slightly stronger minus sphere, and if that helps still further, go on and on until you have brought vision up to $\frac{20}{20}$, or until you reach a point when the stronger minus sphere does not further improve the vision. If, on the other hand, you find that while with the first minus glass tried he sees better, but with the second he sees worse, then diminish the strength of the minus sphere until a point is reached where vision is most acute, and when a still farther reduction in the strength of the glass reduces the acuity of vision. Sometimes we find that the eye is not able to appreciate a variation of .25 or .50 of a dioptre and it becomes necessary to compare true lenses with a difference of 1. or even 2^{D}.

In making these comparisons we may either place them one after the other in the trial frame and ask the patient with which glass he sees better, or we may place one lens in the frame and then place a $+ .25^{D}$ or a $— .25^{D}$ over the first lens. The weak plus sphere thus

held over the stronger minus sphere diminishes the strength of the minus sphere by .25 of a dioptre, while the —.25^{D} adds .25 of a dioptre to it.

If there is any uncertainty as to the glass which gives the best vision go over the ground two or three times and from different standpoints. For example, if you think the best distant vision is obtained with a —2.50^{D} have the patient read the smallest line of test type that he can spell with that glass before his eye. Then place over it a —.25^{D} and have him read with the combination. Or place a —2.^{D} in the frame and alternate before it a —.25^{D} and a —.50^{D}. The first combination making —2.25^{D} and the second —2.50^{D}. If still unable to decide with which he sees better, place a —3.^{D} in the frame and alternate over it a + .50^{D} and a + .75^{D}. The first combination making —2.50^{D} and the second —2.25^{D}.

Having determined with what strength of minus sphere the best vision is obtained, record the result in your record book in the space provided for the same, then proceed to test the other eye in the same manner.

When you have found apparently the best glass for each eye separately, then try the two together and see if you cannot reduce the strength of both by placing a + .50^{D} before each eye and still preserve the same acuity of vision. If so, record the result.

If there is considerable difference in the strength of the glasses and the patient has never worn glasses of unequal strength, you may find that his eyes do not readily adjust themselves to the glasses with which each eye saw best. Then you will fit the better eye and give the same glass to the other eye, or only make a very slight difference in the glasses where a much greater one exists in the eyes.

A myopic person generally thinks he sees well, no matter how poor his vision may be, until he has worn glasses. Then he thinks the glasses have injured his distant vision because he can no longer do without them. Therefore, if the vision is fairly good, we will say $\frac{20}{20}$, it is not best, as a rule, to prescribe any minus sphere at all, either for distance or for near work.

In no case should more myopia be corrected than the ophthalmoscope shows to exist. Especially in children and young persons must we be on our guard. For the giving of too strong a minus glass only tends to increase the myopia. Many authorities urge the use of atropine, especially in youths who are myopic, in order to relax a spasm of the ciliary. Certainly, if it is ever allowable to use atropine, the time to do so is when fitting such cases. But we will show you a more excellent way.

After you have tested the vision with your spheres, place the apparent correction in your trial frames and test the condition of the muscles. You will almost invariably find either an exophoria or a hyperphoria, for these muscular inequalities are usually the cause of the refractive error. Then, while correcting enough of the myopia to give $\frac{20}{60}$ of vision, combine with these minus lenses a correction of the muscular difficulty according to the rules of higher prisms. In this way you will remove the chief *cause* of the myopia and will find that vision will improve in a marvelous manner.

As these pages are written for beginners, we have not discussed the near and far points, nor the way of determining them. Neither have we entered into a description of the various instruments in use for measuring refraction. Nor yet have we considered the methods of using the plane or concave mirror in skiascopy for

estimating the myopia, but we have given the simple method of using the trial lenses and the trial letters.

Suffice it to remark that the trial set is the *sine qua non* of fitting glasses, and when one has made himself master of that he can easily go on to perfection in the study of refraction.

ASTIGMATISM.

Astigmatism is a condition of the eye in which the rays of light emanating from a point are not brought to a focus at any place within the eye, so that a dot appears as a line, an oval or a circle, but never as a point; hence the name *'a*, privitive, (without,) *stigma*, a point.

The optical defect lies in the cornea, which, instead of being round, is egg-shaped, or curved like the bowl of a spoon, having different degrees of curvature in its two principal meridians, which latter are always at right angles to each other. This unequal curvature produces unequal refraction, so that rays are brought to a focus by one meridian in front or behind the place where they are focused by its conjugate. In this way we account for the letters of a printed page seeming to "overlap each other," and their outlines appearing so indistinct.

Astigmation is the most common of all the refractive errors of the eye, as it complicates very many cases of hypermetropia, and still more of myopia. Indeed, all eyes are slightly astigmatic, but the asymetry is usually so little that it occasions no annoyance.

The forms of astigmatism are principally two—the regular and the irregular. Of the second but little need here be said, as it is almost irremediable with glasses, though it may be improved by various other devices.

Of the regular astigmatism there are five varieties:

1. Simple hypermetropic astigmatism.
2. Compound hypermetropic astigmatism.
3. Simple myopic astigmatism.

4. Compound myopic astigmatism.
5. Mixed astigmatism.

In the simple forms one meridian is emmetropic and that at right angles to it is hypermetropic, or myopic. In the compound varieties both principal meridians are hypermetropic or myopic, but unequally so. In mixed astigmatism, one meridian is hypermetropic and the other myopic; this form is somewhat rare, however. Usually, both eyes are affected symmetrically, but this does not always hold true. In most of the marked cases of astigmatism, vision is somewhat impaired by an associated defective retina, or nerve (amblyopia).

Etiology.— Regular astigmatism is congenital, and often hereditary. Occasionally it may be caused by ulcers, or wounds of the cornea, as the cataract operation. It is frequently either caused or aggravated by heteraphoria.

The irregular variety when acquired is due to ulcers, injuries maculae, conical cornea, or a displaced lens; when congenital to irregularities in the refractive power of different sectors of the lens.

Diagnosis. — While the patient is young but few symptoms are manifest, as he is able to largely overcome the defect by unequal contractions of the ciliary muscle. With increasing years the lens becomes less plastic, the eyes are more constantly used, and vision is noticed to be defective. Objects appear differently as he tips his head from side to side, and the eyes become wearied if he use them too long for near work. The letters run together, and distant objects are indistinct in outline. The patient has probably tried many pairs of spectacles, but never found one to suit.

Headache is a very prominent symptom. It may be frontal or occipital; is often nervous, attended with nausea; a headache for which the patient has "tried everything!" Nothing permanently relieves it, because nothing has removed the cause.

Some refer their symptoms to the spine, and complain of severe aching in the neck and down the back, with great weariness on some slight exertion, such as crocheting or reading.

Objective signs.—In the astigmatic subject we frequently note a lack of symmetry in the two sides of the face. To see better the patient often tips the head to one side, and whenever we observe him so doing we may be sure astigmatism is present associated with hyperphoria. With the ophthalmometer it is easy to detect and measure the irregularity.

Tests.—Having failed to bring the vision up to normal with convex or concave lenses, and suspecting astigmatism, we direct the patient to look at a disc of radiating lines in groups of three. Placing it first at a distance of 20 feet, we gradually approach the patient and find out whether at any point he is able to see some of the lines clearly while others are indistinct. If this be the case the presence of astigmatism is proved, and the direction of the most distinct line is also the direction of one of the principal meridians. Various cylindrical lenses placed at right angles to this line until vision is best, measure and correct the trouble. Of course, each eye is to be tested separately.

Ophthalmoscopic Test.—By this the optic nerve disc usually appears oval, instead of round, the long axis corresponding to the meridian of greatest refraction, when we pursue the indirect method, and *vice versa*, when the

direct. As all are not supplied with the requisite appliances for trying the tests already supplied, we will give another and very simple one. Have the patient look through a large pin-hole in a blackened card at a light thirty feet away, If, on moving the card back and forth in one way, the light seems to dance, while it does not do so when the card is moved in a contrary direction, astigmatism is proved to exist.

Various other methods are in use among specialists for the detection and estimation of astigmatism, such as the stenpoic slit, the prisoptometer, Tweedy's optometer, and the ophthalmometer.

Treatment.—No one but an oculist or expert optician should attempt to prescribe glasses for an astigmatic eye since it requires great nicety in locating the angle of the principal axis and a thorough understanding of the theory of irregular refraction. The glasses required for simple astigmatism are cylindrical, i. e., those which are perfectly straight in one direction, but ground convex or concave in the opposite. When the astigmatism is combined with hypermetropia or myopia, a lens which is cylindrical on one side and spherical on the other, is used, while for the correction of mixed astigmatism, crossed cylinders, or combinations equivalent to the same, are to be prescribed. Higher prisms have entirely eradicated many cases of astigmatism of low degree, and reduced it where it existed in high degree. No eye-glasses except those with a straight spring should be used, as it is necessary to preserve the proper axis of the lenses, but spectacles should be ordered for constant use. Medicinally, agaracus, jaborandi and physostigma are beneficial where unequal contraction of the ciliary muscle exists. Atropine will

relieve the headaches temporarily. Nothing except higher prisms will eradicate the trouble.

Prognosis.—Recent investigations have shown that uncorrected astigmatism threatens the integrity of the eye. In myopia astigmatism we most frequently find distinct lesions in the back of the eye, while hypermetropic astigmatism produces posterior choroiditis and atrophy around the optic nerve disc. "Astigmatism predisposes to myopia," said Javal, "since it is eyes affected with hypermetropic astigmatism, which pass over and become progressively myopic."

Hence, astigmatism in early life may truly be said to be a most dangerous optical defect. In school children, therefore, whenever there is a doubt in regard to the optical condition of the eyes, it is the duty of the teacher and of the family physician to advise that they be carefully examined by a competent ophthalmic surgeon, or an expert optician.

CORRECTION OF ASTIGMATISM.

Having found that neither plus nor minus spheres give perfect vision, and being convinced by the symptoms and tests that astigmatism is present, we begin the use of cylinders to determine the amount of the refractive error.

First, however, we attempt to improve vision as much as possible with plus spheres, or, in other words, we leave in the trial frame the strongest plus sphere which does not injure the vision, for if the error is at all hypermetropic in nature, and this is usually the case, we want as full a plus correction as possible. If the astigmatism is myopic all plus spheres will impair vision, and then we must begin with the weakest minus sphere which gives the best spherical correction.

The patient is next directed to look at the astigmatic chart. If he sees the lines in one direction plainer than those at right angles to them, we place in the trial frame over the sphere a plus cylinder of .50^{D} the axis being in the direction of the most indistinct lines seen on the chart. This will either make these indistinct lines plainer or dimmer. If plainer, we know that the astigmatism is hypermetropic, the axis being approximately the one now occupied by the cylinder. If the vision is not at once brought up to normal, we vary the axis slightly (5 to 15 degrees) to each side of the position at first occupied by it, and observe the exact angle at which the cylinder gives the best vision.

If, however, the best vision procurable with this cylinder is still imperfect, and the lines on the chart are still of unequal distinctness, we replace the + .50^{D} cylinder with a stronger, as + .75^{D}, or a weaker as + .25^{D}, as the case may require, preserving the axis already found until we arrive at the best result obtainable in that direction.

For example, suppose with the right eye vision is $\frac{20}{80}$ without glasses. Covering the left eye we bring vision up to $\frac{20}{60}$ with + 1^{D}. spherical, and find that both stronger and weaker spheres make it worse. With the + 1.^{D} sp. before the eye the horizontal lines are very distinct and the vertical lines are dim. We then place over the + 1.^{D} sp. a + .50^{D} cy. ax. 90°, *i. e.*, vertical. This combination improves the vision so that the patient can now read line XL, *i. e.*, V. = $\frac{20}{40}$. Varying the axis to either side of 90° (viz., to 80° or 100°) makes vision worse. We therefore decide that the case is one of compound hypermetropic astigmatism, and that 90° is approximately the correct axis.

But vision being still imperfect we replace the + .50^{D} cy. with a + 1.^{D} cy. ax. 90. This brings vision up to $\frac{20}{30}$. Any change of the axis makes it worse. Again, changing the cylinder to + 1.50^{D} axis 90° gives vision = $\frac{20}{20}$, and a reduction to + 1.25^{D}, or an increase to + 1.75^{D}, impairs vision. We have, therefore, reached the conclusion that + 1.^{D} sp. $\supset$ + 1.50^{D} cy. ax. 90° gives perfect vision, and that + 1.50^{D} cy. 90° is the measure of the astigmatism.

To verify this result we place a + .25^{D} cy. ax. 180 and a —.25^{D} cy. ax. 180° alternately, over the above combination and see if either of these improves the vision, Both failing to do so, our correction stands. We should next try to see if we can add a + .25^{D} sp. and still retain vision $\frac{20}{20}$.

Returning now to the point where we first applied the + .50^{D} ax. 90°, let us suppose that it makes the vision worse rather than better, what shall we conclude? Either that the cylinder is too strong or that the cylinder should have a different axis. To determine the first point, we reduce the strength of the cylinder to + .25^{D} ax. 90°. If vision is still impaired we revolve the lens so that the axis is 180°. This we may find gives better vision than when it occupied the former position, but the patient sees better without the cylinder altogether. We must next try placing a— .25^{D} cy. ax. 90° in the frame over the plus sphere already there. If this improves the vision we replace it with stronger and stronger minus cylinders until we reach the best attainable vision with these minus cylinders axis 90°. Next we vary the axis from side to side, and determine the exact angle at which the sight is most improved. Again we increase and decrease the strength of the cylinder. Again we attempt to add to the plus sphere without impairing vision already attained, until at length we arrive at perfect vision, and find that any departure as to strength of lens or direction of axis impairs the vision. We must next test the other eye in the same manner, and having reached the acme of vision with each eye separately, we try the two eyes together. If both eyes require the same lenses, the vision with the two eyes will be better than with either alone, and it may be that with both eyes open a + .25^{D} sp. can be added to each without impairing vision. If so, it should certainly be done. In prescribing it is always well to cut the cylindrical correction a little even at the expense of vision.

If the two eyes are very uncomfortable when thus corrected and used together, and there is a marked

disparity in the strength of the two lenses, it is best to fit the better eye and cut the amount of the correction of the other, so that the two will work comfortably together. For example, to-day I received a letter from a former student in Kansas asking advice in the following case: C. S., age 34. V. = R $\frac{20}{70}$. L $\frac{20}{100}$. With + 1.12^{D} cy. ax. 180° R = $\frac{20}{30}$; with — .75^{D} sp. ⌒ + 1.50^{D} cy. ax. 155° L = $\frac{20}{70}$. The two do not work well together. I advised him to try R. + 1.^{D} ax. 180° L + 1.^{D} ax. 155° combined with higher prisms, and from an experience of thousands of such cases I am confident that the lenses will work together charmingly. What we have here written is the merest outline, the A B C, of the subject under discussion. In practice we quickly learn to leave out many of the intermediate steps here described, and we substitute other methods of testing, such as those involving the use of the ophthalmometer, the prisoptometer, skiascopic and ophthalmoscopic measurements. But if the beginner will master the slower method herein described, he can easily acquire the others later.

PRESBYOPIA.

Presbyopia is a term derived from two Greek words signifying "old age" and "eye," and means that physiological failing of vision due to advancing years. It affects all eyes, regardless of the condition of their refraction for distance, and manifests itself more especially in reading and other near work. This is due to the recession of the near point through failure of the accommodation, and is relieved by adding plus spheres to those glasses which give best vision for distance. As an old writer has quaintly put it, these glasses "postpone the twilight of old age and keep the curtain from falling until the play of life is done."

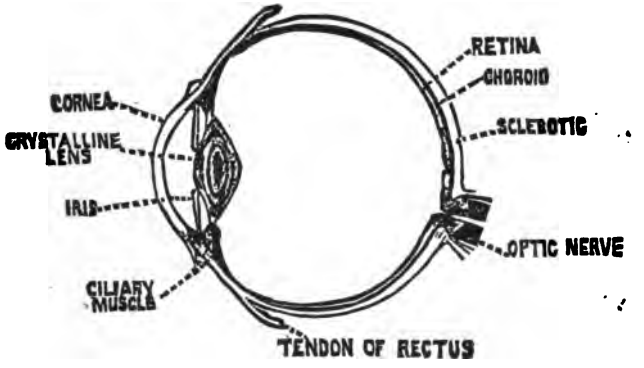
In order to understand the conditions it will be necessary for us to refer briefly to the anatomy of the eye and the mechanism of accommodation.

In the accompanying illustration it will be seen that the lens is suspended in a delicate ligament which is attached to the ciliary muscle in such a way that when the round fibers of the muscle contract this suspensary ligament is relaxed. The crystalline lens is very elastic in youth and tends to assume a globular form, but is flattened from before backward by the tension of the above mentioned ligament. When, therefore, the ligament is relaxed the lens becomes more convex, and thus its refractive power is increased and the eye is enabled to clearly perceive objects near at hand.

This act is termed the accommodation of the eye. One is usually unconscious of it, but by holding the

finger fifteen inches from the face and alternately looking at it and at some object in the distance, we can actually feel the change taking place in the eye.

Closely associated with accommodation is convergence of the eyes through the action of internal recti muscles in turning the eyes slightly in, so that the visual axes of the two eyes will both be directed to the same near point. Whenever convergence is strongly exercised the



accommodation is also brought into action, and the weakening of either of these forces produces distress. Their relationship will be more fully discussed when we reach the chapter upon heteraphoria.

As age advances there is a marked and progressive hardening of the lens. This process begins as early as the tenth year of life, and reaches its maximum at seventy to seventy-five. As the lens becomes less elastic it loses its power of refraction, and hence of accommodation. At ten years this power amounts to 14^{D}. At twenty, to 10^{D}; at thirty, to 7^{D}; at forty, to 4^{D}; at fifty, to 2^{D}; at sixty, to but 1^{D}. For ordinary reading pur-

poses the eye needs 4^D to 4.5^D of accommodation. When less than this amount is possessed the eye becomes very tired, or the book must be held at a greater distance from the face than 22 c.m., which is the usual distance. Hence Donders has established the proposition that presbyopia begins at that time when the nearest point of clear vision is greater than 22 c.m., and the age at which this occurs averages about forty. Many things modify this average, as we shall see later.

The symptoms which presbyopia occasions are inability to see to read at the ordinary distance, as well as formerly, although distant vision is unimpaired. This is especially noticeable at night or by artificial light. The patient holds his book at arm's length and strains his eyes to see the print, the effort becoming greater the longer he reads. Finally, he becomes sleepy and lays the book aside, or if he persists his eyes begin to ache and burn, and the next day even they are far from comfortable.

The treatment is purely mechanical, in adding to the outside of the eye what nature fails to supply to the inside, viz.: a plus sphere added to the glasses for distance. If the latter are already plus spheres for hypermetropia, then the reading glasses will be stronger plus spheres. If the distant glasses are minus spheres the reading glasses will not be so strong as they otherwise would have been at the given age. If the minus spheres for distance are of the same strength as the presbyopic change requires, the old gentleman will be able to read best without glasses, for the myopia exactly neutralizes the presbyopia at the near point. If the myopia exceeds the amount of presbyopia then the glasses for reading will be weaker minus spheres than those for distance.

CORRECTION OF PRESBYOPIA.

Sometimes a person comes to an optician and says he wants glasses for reading, and expects you to pick out a pair of "reading" glasses at once. When you begin to test his eyes for distance he impresses his wishes upon you again, and if you insist that you must fit for distance before you fit for reading, that whatever you do must be done correctly, he forthwith departs, informing you that he will go to "some one who knows his business." Such a patron is not worth having. If he has not sense enough to realize that you, an expert, know more about fitting his eyes than he does, you may well bid him adieu, for the paltry profit on a pair of cheap glasses is more than offset by the harm he would do you afterward, when he found that the glasses were not suited to him.

Never fit for reading until you have first fitted for distance. There are many reasons for this. Astigmatism may be present in sufficient amount to require correction, and this can be determined more easily in the test at twenty feet than in that at the reading distance. One eye may not have the same refraction as the other. This can be readily detected by the first, but not by the second test. There may be present a marked heterophoria of some kind, and the knowledge of it will influence your prescription of reading lenses.

A presbyopia is a recession of the near point due to age, and *the prescription must be founded upon the refraction for distance and modified by the amount of the recession of the near point.* This recession amounts to

about one dioptre for every five years after forty. For example, the patient is fifty years of age and has a hypermetropia of two dioptres. His reading glasses will, therefore, be approximately + 4.D, *i. e.*, + 2.D for hypermetropia and + 2.D for presbyopia, total + 4.D. Again, the patient may be sixty with a myopia of three dioptres. His reading glasses will, therefore, be about + 1.D, *i. e.*, —3.D for myopia and + 4.D for presbyopia, giving a total of + 1.D.

We say *about* one dioptre for every five years after forty, for it was long since discovered that we must fit the eyes and not the years. Gulliver's experience with tailor-made clothing in the land of the Lilliputians must not be repeated by scientific opticians of the present day. Many things enter in to modify the rule, if its numerous exceptions may allow it to be so designated. For example, a strong man with emmetropic eyes does not require glasses as quickly for presbyopia as a weakly woman. A beginning cataract or an incipient glaucoma change its application, the former reducing the strength of the presbyopic lens and the latter adding thereto. A tall person naturally holds his book at a greater distance than one of diminutive stature, and hence does not so soon fall under the necessity of requiring plus spheres to aid him in reading, neither does he require such strong ones at a given age as the man Zacheus. A pianist, a surgeon and a carpenter require a longer focus for their work than is adapted to reading. Again, after the age of sixty the ratio of increase is less rapid and ceases altogether at three score and ten.

Having fitted each eye separately for distance and then modified this correction so that the two eyes work well together, we give to the patient the reading test

and place before his distant glasses the plus spheres which are called for by the above rule, bidding him hold the test at the distance he usually wishes to read. This distance varies from ten to fifteen inches from the face. If, with the combination now before his eyes, he can see better at a nearer point than at that required, the presbyopic addition is too strong; if at a greater distance it is too weak. We therefore substitute other lenses a half dioptre stronger or weaker, as the case requires, and notice if the distance is now that which he wishes. If not, we again modify the lenses as before. Having at length found the glasses with which the patient reads well, we place over them + 25^{D} and — $.25^{D}$ alternately to see if at the chosen distance vision can be rendered still better, both eyes simultaneously having the same addition.

When the best spheres are thus found, we add prisms according to the condition of heteraphoria present, governing the strength according to the laws of the science of higher prisms. In this way we render comfortable for continuous use glasses which would otherwise give relief at first, but soon after cause burning and distress.

Again we find that an astigmatism which has remained uncorrected until old age must be materially undercorrected in a reading glass, a half dioptre at least being ignored, especially if it be a plus astigmatism axis 90°, or a minus axis 180°, and it is safe to correct but half of the remaining astigmatism. Especially is this the case if the patient does not wear glasses for distance.

Where a marked hypermetropia exists which has never been corrected, we insist that our patient shall wear glasses for distance continuously for one month before he is fitted for reading. If he refuses, we tell him to go elsewhere. Our first object is to preserve

our own reputation. That is of more value to us than his money. If he will not do what we know is best for him, we refuse to treat him, and it is rarely that we fail to keep the patient and to give satisfaction. However *satisfaction must never be promised.* Often the best glass for the patient is not satisfactory at first. It may not even be comfortable, but we know that if we follow the rules of higher prisms we cannot do harm.

One word in regard to bifocals. Do not use them if you can avoid it. There are three reasons for this: 1. The reading lens is usually added to the inside of the glass for distance. The line of vision for reading is therefore not at right angle to the lens, and the obliquity produces a cylindrical effect, causing an artificial astigmatism. 2. The "chips" are so small that the field of vision is very limited, and if the presbyopia is great they interfere with seeing the ground as one walks. 3. Proper prismatic combinations cannot be employed.

All of these objections can be avoided by the use of grab fronts, which are very handy and in which the lenses are easily and cheaply changed as the presbyopia increases.

All eyes should be retested as often as once a year, and the glasses exactly adapted to the case. A foolish notion prevails among a certain class of people to the effect that they should do without glasses as long as possible, lest having begun to wear them they can never leave them off. As well might a mother refuse to nurse her new-born child fearing that when it has once established the habit of eating it can never stop. The needs of the eyes should receive prompt attention, and it is the duty of the oculist and the optician to enforce this observation upon all occasions.

MUSCULAR ASTHENOPIA.

Insufficiency is a form of Asthenopia, characterized by very troublesome symptoms, due to an inability to maintain convergence of the eyes for near objects for any length of time.

The trouble consists in a weakness of the internal recti muscles (those which turn the eyes to the median line), so that they are unable to oppose their antagonists, the external recti; and the extra exertion constantly put forth, in the effort to retain binocular vision, wearies the eye and compels rest.

The occurrence of this trouble is not at all infrequent, and it should be suspected in Hypermetropia if symptoms of Asthenopia persist when using the glasses which correct the refractive error. In Myopia, also, it complicates many cases, especially those of high degree.

Etiology.—The trouble is due to an unequal development of the external and internal recti muscles. Myopia frequently brings it to light. If, in that trouble, the far point of perfect vision is twenty inches, to see an object there the patient must relax all of his accommodation, and yet use considerable power of convergence to cause both eyes to bear upon the object. The disturbance in the relation of the two functions (accommodation and convergence) which should go together, and the constant, painful struggle to disassociate the two, wearies the eye and enervates the internal recti.

Again, the trouble may co-exist with hypermetropia, since here again a disturbance in the equilibrium of accommodation and convergence is readily developed. In this case the accommodation is in excess.

Other causes which bring the trouble to light are general debility, wasting disease and parturition, since the eye suffers with all the other organs. The excessive use of tea also has been found to enervate the internal recti and produce insufficiency.

Diagnosis.— As in accommodative asthenopia, the usual complaint is that the eyes become tired; especially at night, there is pain in and around the eyes when they are used; vision is indistinct; the letters seem unsteady, and at times appear double. Sometimes there is a sensation as of the eye deviating outward, "which may really be the case, the patient finding relief by closing one eye." Certain forms of headache, resisting all treatment, are due to trouble of the ocular muscles, and disappear when these are relieved. The pain in these cases is over the eyes, through the forehead and temples, and is aggravated by using the eyes.

Objective Signs.—Although the trouble is often associated with hypermetropia and myopia, there may be, in some cases, no error of refraction and the eyes appear perfectly normal.

If the finger or a pencil is gradually approached to the face, when within six inches, one eye may be found to deviate or turn outward. This only occurs in marked cases, however.

Hartridge's Test.—The patient is directed to look at the point of a pencil, held about fifteen inches from the face, with one eye, while the other is excluded by a card.

The pencil is now gradually approached; the covered eye being watched, at a certain point will be seen to deviate slightly outward. As soon as it is uncovered it makes a corresponding movement inward to again fix the object. The reason of this is that when one eye is covered the stimulus to binocular vision is wanting, and the covered eye is left to the control of the stronger muscle.

Another and better test is to place a prism of 10, base down, before the right eye, and have the patient look at a dot on a white card. He will see two dots one above the other. If one is indirectly above the other, there is no manifest insufficiency present; but if the upper dot is to the left, the internal recti are deficient.

Treatment.—The treatment must be directed at the cause of the trouble. When this is general debility we must build up the system; if an error of refraction, that must be corrected; if excessive tea drinking, that must be stopped. Weak prisms, with the bases towards the insufficient muscles, give speedy relief as a rule. We must, however, be on our guard, lest the apparent insufficiency is due to spasm of the opposing muscles.

In Myopia the simple correction of refraction often relieves the entire trouble. Sometimes, however, it is necessary to combine with the correcting lens a weak prism, in order to give entire satisfaction. Where the health of a patient is good and a 2° or 4° prism does not effect a cure, it becomes necessary to resort to other methods. The more radical authorities advise an immediate tenotomy. I never operate unless there is an insufficiency of at least 10°.

The use of higher prisms depends upon so many cir-

cumstances that it is impossible to describe them here. Often an apparent insufficiency is due to a spasm of the opposing muscle. There is frequently a latent trouble or even a reverse manifestation. Reflexes from one set of muscles to the other are often found.

HETERAPHORIA.

Muscular insufficiency is the name formerly applied to a condition the opposite of which we now designate as some form of heteraphoria. Strictly speaking it designates a lack of balance of a set of opposing muscles of the eye due to weakness or inability of one of the muscles to compete with its antagonist.

Heteraphoria views the subject from the standpoint of the stronger muscle and indicates a tendency of an eye to turn toward that muscle. However heteraphoria is a term of much larger scope than insufficiency in this that the latter simply applies where there is a manifest lack of balance, whereas heteraphoria takes cognizance of those conditions of anatomical inequality of opposing muscles even when a strong nerve impulse causes the longer (weaker) to fully balance or even to over-balance its opponent.

Varieties.—Heteraphoria comprises exophoria, a tendency of the eyes to diverge; esophoria, a tendency of the eyes to converge; hyperphoria, a tendency of one eye to turn upward; cataphoria, a tendency of one eye to turn downward, and cyclophoria, a tendency of one or both eyes to be abnormally rotated on its anteroposterior axis, either out or in.

Causes.—The causes of heteraphoria are anatomical shortness, or excessive development of muscle; also paresis, paralysis, or lack of development of its antagonist. False or pseudo-heteraphoria is due to spasm of the naturally insufficient muscle which makes it appear even stronger than its antagonist.

Anatomy.— Each eye is controlled by six extrinsic muscles. The superior rectus, which turns the eye upward; the inferior rectus which turns it downward; the internal rectus which turns it toward the nose; the external rectus which turns it toward the temple; the superior oblique which turns it down and out and twists it inward, and the inferior oblique which turns it up and out and twists it outward.

The action of each of these muscles and their relation

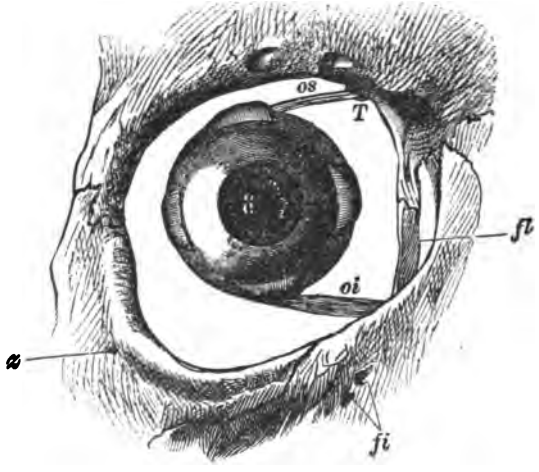


Fig. 1.

to each other and to the various refractive conditions is a most interesting and instructive study.

Any one of these muscles may be too short, thus tending to turn the eye in its direction. To offset this the nerve centers send an excessive impulse to the opposing or long muscle. The eyes may thus be held straight, but it is at the loss of great nervous energy.

Tests.—There are many tests for the condition, some good and some almost worthless. Among the latter may be classed the test given in our text books of ten or twelve years ago, *viz.*, the dot and line test. A line with a dot at its middle point is held vertically before the face, both eyes being open, a prism of 4° to 6° base down, is held before one eye, causing two dots to appear; if both were upon the line there was assumed to be no

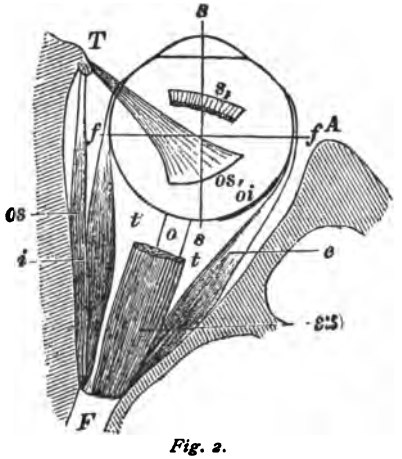


Fig. 2.

hetoraphoria. One reason that this test is of no value is that it will only reveal cases of very marked unbalance of the muscles, for if the internal and external recti are anywhere near equal, the fusion stimulus of a plain vertical line will overcome the insufficiency of the long muscle and both dots will appear on the line. If now the line is held horizontally, the head being erect, and prism base down, and the dot on one line appears directly over the dot on the other line, which latter is seen with the uncovered eye, the test is of decidedly more value, for

unless there is manifest hyperphoria, fusion is improbable and there is no stimulus to binocular vision. However this test is open to the same objections as any other diffusion test, *viz.*, that it will only reveal the manifest heteraphoria while the latent are wholly concealed from it. The latter can only be brought to light by higher prisms.

Another diffusion test which is in common use is the test with Maddox glass rod. The idea is that both eyes may look upon the same object without recognizing it

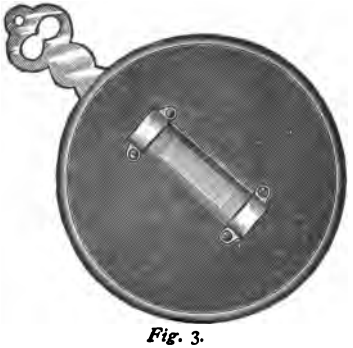


Fig. 3.

as the same and so be deceived into allowing the fusion stimulus to slumber, and it is stated that "the eyes will assume the position where the greatest muscular ease is afforded." While the argument is easily proved to be false, nevertheless the test is a good one so far as it goes, *i. e.*, whenever this test reveals an heteraphoria, there is one present, even though it be the reverse of the one shown. But this test will not reveal the exact inequality of the muscles, neither will it bring to light any latent defect as higher prisms will.

The manner of testing is to place a lighted candle or other small bright light twenty feet from the patient, who is seated in a darkened room. A trial frame is placed upon the patient, containing the tester, with the axis horizontal, before the right eye (Fig. 3). The flame as seen through the tester is a streak of light, and either passes through the flame seen with the left eye, (Fig. 4), in which case there is no apparent horizontal

Fig. 4.

Fig. 5.

Fig. 6.

heteraphoria for distance, or it goes to the right of the flame, (Fig. 5) which seems to indicate esophoria; or to the left, (Fig. 6) which does indicate exophoria.

The tester should now be turned in the trial frame so that its axis is vertical. The streak of light will be seen to be horizontal. If the streak passes through the flame centrally, there is no apparent vertical heteraphoria. If it passes above it there is apparently left hyperphoria; if below it there is apparent right hyperphoria. To

determine whether any of these conditions are true or false it is necessary to use the higher prisms. But it is generally supposed that they are true. The measure of the apparent error is that prism which causes the streak to go through the light centrally.

Effects.—Heteraphoria produces disturbances of the nervous system of a very marked character. To demonstrate this, place upon yourself two 10° prisms, bases out, and wear them for a day. And yet this (20°) is a very moderate error, as any one can prove with higher prisms. Or, put a 2° prism base up before one eye, and a 3° prism base down before the other and read with it an hour and then wear it the rest of the day. Nothing will convince a man like a test of this kind.

Now I want to make a statement which you can verify in your own observations easily. It is this. In nine out of every ten cases of insanity, epilepsy, neuralgia of head, constant headache, excessive nervousness, nervous prostration, asthma, diabetes, spinal affections, paralysis, shaking palsy, stammering, inability to talk, twitching of muscles, chorea, inability to walk straight, locomotor ataxia, mania-a-potu, spasmodic affections of uterus, bowel or bladder, hysteria, and a host of other affections of a nervous character, that a careful test will reveal some heteraphoria, which is either a predisposing cause or an aggravating accompaniment of the disorder. In my own practice I have demonstrated this over and over again, by curing the trouble without a drop of medicine by simply removing the heteraphoria. Of course, this will not cure all cases, because there may be other sources of irritation. But an existing heteraphoria aggravates the trouble and should be removed.

OCULAR REFLEXES.

Nervous reflexes originate from irritation of nearly every organ of the human body; so we will pass directly to the more limited subject of ocular reflexes with which we have to deal.

Let us first group certain well attested phenomena and then deduct what conclusions seem most reasonable.

A cinder imbedded in the cornea causes the lachrymal gland to pour forth an excessive flow of tears; this is a direct corneal reflex. An injury to one eye frequently awakens a so-called "sympathetic" inflammation in the other, and the removal of the wounded eye is followed by the immediate disappearance of the irritation in its fellow; this is direct ciliary reflex.

A hypermetropia causes occipital headache, and an astigmatism frontal headache; these are direct refractive reflexes.

The sight of a man falling from a great height arrests the breathing; fainting is frequently observed in the uninitiated who witness a bloody surgical operation; nausea may be caused by seeing the waves beating against the wharf or by standing close to a slowly moving train of freight cars; one's mouth is made literally to water when beholding a picture of ripe, luscious fruit. These are examples of indirect ocular reflexes.

Every gynecologist recognizes the intimate relation which exists between the eyes and the uterus, as each frequently reacts adversely upon the other. No parturient woman should read, because of the weakened

condition of the eyes from uterine reflex, and dysmenorrhœa is frequently caused by eye strain, and is relieved by higher prisms.

Let us now go a step further and consider certain hitherto not commonly recognized ocular reflexes and the manner in which they may be produced. New glasses, even though correctly adjusted, sometimes cause nausea; and conversely a gastric trouble of years standing has been entirely relieved by wearing the correct lenses.

Prisms adjusted to effect the eye muscles generally produce a temporary unsteadiness in walking. The same effect sometimes follows a tenotomy of one of the long muscles. On the other hand, I have had three cases of strabismus associated with inability to walk straight, upon which I operated for the sake of the appearance of the eyes, when lo! the impediment of gait disappeared.

Gelseminum produces a dizziness and staggering. How? By interfering with the normal enervation of nerve impulse to the long muscles of the eye. Alcoholism tangles the feet badly in the same way, and you can unravel the snarl by instilling atropine into the eyes. Keeley's "cure" dims the vision because of the atropine his medicine contains; and as long as the patient is under the influence of his remedies he does not care for liquor.

Our sixth or muscular sense, viz., our idea of distance is governed by the effort required to converge and accommodate the eyes upon an object, and when prisms are so adjusted as to change that effort we are at sea, both as to measurement of distance, and co-ordination of movement. Hence, it is easy to understand how chorea

and stammering are ocular reflexes, and how they may be, and are relieved by higher prisms. To demonstrate this, reverse the prism which gives the most relief and you will markedly aggravate the malady, thereby proving that the beneficial effect of the treatment is not hypnotic, as certain prejudiced individuals have claimed.

When a marked heteraphoria is corrected by a tenotomy, all of the sphincter muscles of the body seem to relax. A spasmodic asthma ceases. A scanty menstruation is succeeded by a profuse flow; a chronic constipation of years standing is at once relieved; the bowels become regular and the movements free and easy. The tension is gone. The guy-ropes are cut. The strain is over. Conversely certain paralyses, not due to a central lesion nor to severed nerves, find instant cure when the cause is removed by relieving an eye strain. Do you disbelieve this? Let me relate a case.

Through Mr. Warring, one of our Dunham students, I was called to North Harvey eight weeks ago to see a Mrs. D., aged 38, who was suffering from paresis of the throat to such an extent that she was unable to swallow any solid and but very little liquid food. She was slowly dying of starvation. Family history bad, several near relatives having died of tuberculosis. There was chronic, terrible constipation and great melancholy.

I found four degrees of exophoria and a slight hyperphoria of one eye. Although she protested that her eyes were the only perfect organs she had, I induced her to wear higher prisms which corrected the apparent muscular trouble. Four days later I found the exophoria had developed to 28 degrees. On New Year's day I performed a tenotomy and although I completely severed

the external rectus of the left eye it did not turn the eye in at all. This was followed by marked improvement in all her symptoms. A week later still more exophoria having developed, the right external was cut. This temporarily caused cross-eye and unsteadiness of walking, both of which symptoms were corrected by higher prisms and have since disappeared. But *the paresis had entirely vanished.* Monday, January 13, 1896, she went home a well woman. That morning she ate a hearty breakfast of mutton chops, potatoes, etc., and had no difficulty in swallowing. The bowels were free, (they usually yield to the first treatment by prisms) and she declared she was better than she had been for sixteen years.

Several physicians have reported cases of diabetes cured by glasses. This, I have not personally accomplished, but I have increased the flow of urine by means of prisms, and I believe that an abnormal discharge may be stopped by refractive and muscular correction.

Now, I do not believe that "everything except fracture" may be cured by glasses. But I have seen cases of rheumatism and incipient consumption vanish without a drop of medicine, and I have watched a man who for three years had not taken a step, in whom locomotor ataxia was well developed; I have seen that man after three weeks treatment with higher prisms, arise unaided, and walk with canes six hundred paces without resting. I have seen my dear old father's hand, which has for a long time been violently shaking with palsy, quiet down very markedly. It is not yet entirely cured, but it is not half as bad as it was. I have seen two cases of insanity (melancholia) recover; and I have seen two cases of inability to talk in children of eight

and six years, so wonderfully improve within a month after removing the abnormal ocular reflex, that even I was astonished thereat.

In conclusion, may we not state without contradiction, that it is very difficult to cure many people until the cause of their trouble has been removed. If this disturbing element be an ocular reflex, it ought to be recognized and eliminated. Then, as the renowned Dr. Cowperthwaite has often declared, "It is easy to cure your patient."

HIGHER PRISMS AN AID IN THE TREATMENT OF INCURABLES.

The first duty of the physician is to search out and remove the causes of disease. Nearly all diseases have two causes, a constitutional or predisposing cause, and an external or exciting cause.

It is not enough that the corn planted in your fields be good. The soil must also be favorable to its growth or it will not produce the bountiful harvest you desire.

All vegetation is dependent for its full development both upon a germ and a favoring environment. So in disease there must be both a disease-producing influence and a susceptible constitution.

Small-pox is admitted by all to be a contagious affection, but when I was in general practice, many years ago, I treated several cases of a malignant type, visiting them daily, yet I did not contract the disease. Why? Because, through a kind Providence, my system was enabled to resist the disease-producing influence. Everyone is exposed to consumption. One contracts it, another does not. The influence exerted on both is the same, but the constitutional condition is not the same.

What then makes one susceptible to disease? We answer, anything that lowers the vitality. All of our thought, action, energy and health, center in the nervous system, and whatever impairs the nerve force to any degree, deprives the system of its disease-resisting power in an equal amount.

Let us illustrate. Here is a motor car, which in order to climb yonder grade, must resist and overcome the force of gravity which holds it back. Its trolley touches the wire, and it moves forward to the foot of the incline, and stops. It has not sufficient electrical force to propel it upward. Either there is not enough electricity generated, or it is drawn off nearer the power-house by a shorter circuit. So in man, the gray matter of the nerve centers produce nerve force, but if too much of that force is drawn off or used up in some other way, there is not sufficient left for the work of life.

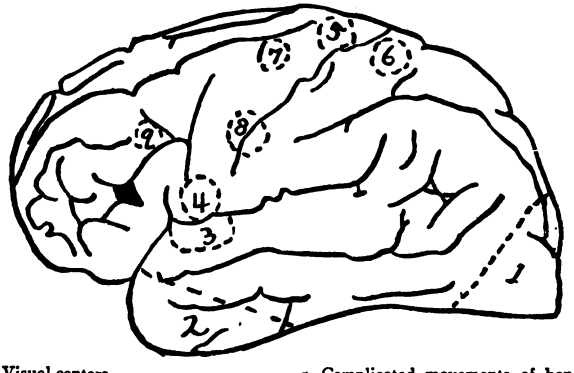
Given a certain amount of constant drain, in perfect health the system may not appear to feel it, but subject that person to an excessive strain, such as child-bearing, and this drain prevents the rapid recovery we had a right to expect. In persons, especially women who have but little vital energy, the smallest drain is quickly felt. On the other hand, where great nervous force is generated, but where there is a disturbing element at the nerve center, this very excess of energy is liable to be reflexed (switched off) into some other channel, notably that of the appetite or sexual system, and undue excitability is aroused, which when stimulated by indulgence becomes absolutely uncontrollable and the man becomes a dipsomaniac (drunkard) or a libertine.

This is an age in which we have learned to recognize the wonderful power of nervous reflexes. They occur in all parts of the body. Why not from the eye? As Prentice says* "the visual centers are the largest, (Fig. 1), the most sensitive, and the most constantly taxed." To a certain extent every physician recognizes that headache and neuralgia may be generally and are due to

* The Eye in its Relation Health. A. C. McClurg & Co.

eye-strain, and the doctor who continues for years to prescribe for an incurable headache without having the refraction of his patient examined by a competent oculist or optician is either unprincipled or ignorant.

But eye-strain causes other reflexes beside headache; and eye-strain is due not alone to a faulty refraction but also to an inequality of the opposing long muscles (the *recti*), which keep the eyes straight. In fact, it is this



1. Visual centers.
2. Taste, smell and sexual feeling (centrally located).
3. Hearing.
4. Face, tongue and speech.
5. Complicated movements of hand, arm and leg.
6. Coarse leg movements.
7. Coarse arm and leg movements.
8. Coarse arm movements.
9. Writing images.

inequality which causes so many cases of cross-eye. Did you ever know a person who had lost the sight of one eye for a year or more whose blind eye did not turn out or up or down or in? A very superficial examination will reveal such a condition in 95 per cent of all cases. Why is this? Simply because the stimulus to binocular vision having been removed, the blind eye turns in the direction of the shortest muscle, Was that muscle shortest before such loss of vision? Certainly, but the

defect was concealed by an excessive contraction of its antagonist and thus both eyes were held straight. The eyes of the new-born babe are seldom straight, and one eye of a person dead for 25 hours is almost always turned. When you consider the constant use of the eyes for 15 or 16 hours every day, and often at near work, the exact position required of each eye for accurate vision, and the excessively sensitive nature of the retina, you gain some idea of the tremendous expenditure of nerve force required to hold parallel the optic axes of two eyes when one naturally tends to stand from 10 to 25 degrees higher than the other, or where they tend from 20 to 30 degrees apart horizontally.

Practically, what is more tiresome than sight-seeing, unless it be the guiding of a span of spirited horses, and that is done by muscles many times greater proportionally than those which hold in check the restless orbs of sight.

When one eye permanently turns, the effort to maintained single vision ceases, and the nerve-strain likewise. Many a case of St. Vitus' dance (Chorea), has stopped when the child became cross-eyed. But how many "incurables" have "suffered much of many physicians, and were nothing bettered, but rather grew worse," because the severe eye-strain which never ceased was not relieved. An apparent strabismus is corrected for appearance sake. Of how much more importance is it to correct a latent strabismus which is either draining the system of its nerve force, or causing reflex troubles such as those mentioned.

A short time ago a case was sent me by Dr. A. C. Cowperthwaite, whose work on Materia Medica, has gained him a national reputation. It was a lady on the

verge of insanity. In fact, she was insane; melancholia being the form of her disease. She would sit and cry by the hour, over imaginary troubles. She was very near-sighted, and ignorant opticians had greatly increased her trouble by giving her too strong glasses. On testing I found (when the eyes were disassociated), that the left eye stood 30 degrees above the right, although they were usually held straight by an unconscious but terrible effort, which was draining her mind of reason, her eyes of sight, and her life of joy.

I first brought to light the full amount of this inequality with higher prisms and then operated for the invisible strabismus, and fitted her correctly, thereby not only reducing her apparent myopia from 26 to 16 degrees, but relieving her of that terrible strain, so that a cure was rapidly effected by the very Pulsatilla which had before been prescribed but without results.

Dr. Sparling, of Chicago, sent me a man with incipient consumption whose eyes were troubling him. He had been fitted several times but without comfort. On examination I found vision above normal, there heing considerable far-sightedness (2 D), but more important than this, the internal *recti* (muscles which turn the eye inward) were apparently shorter than the external (*esophoria*). I had reason to believe that this was spasmodic, and that the external muscles were really the short ones (*exophoria*). I began a systematic correction of the trouble with higher prisms, with a view to developing all inequality that might be hidden or latent. In the course of two months I had prescribed six pairs of glasses, increasing the strength as he was able to bear it, when I found that his true condition was a turning out of the eyes 15 degrees. This was corrected with

prisms. He could then use his full corrections for far-sightedness with perfect comfort and perfect sight. But most remarkable was the fact that the same medicine which the doctor had before given without effect now stopped his cough, increased his strength, and caused every symptom of his disorder (the disease with which his father died) to disapper! All this because the short circuit whereby his vital electricity (nerve force) had been drawn off was interrupted by means of prisms, and his disease-resisting power was thereby conserved, to aid the doctor in his cure.

Had I space I could enumerate cases of deafness, nervous prostration, paralysis, diabetes, chronic rheumatism, and asthma, which were quickly cured after the ocular reflex had been removed. *Not that the prisms alone cured them; but the removing of a predisposing cause made them curable.* In every case of consumption and drunkenness which I have tested, and they have been many, there was invariably a marked inequality of the ocular muscles.

How can you test for inequality? Thus: In a darkened room seat your patient before a table upon which is a lighted lamp turned so low as to leave but a narrow flame visible. Place your trial frame before the right eye, a Maddox bar, or muscle tester. When the bar is vertical a horizontal streak of light will be seen. If this runs through the flame centrally, there is no apparent vertical inequality. If it is below the flame, there is manifest right hyperphoria of such an amount as is measured by the prism, base down, before that eye, which causes the streak to pass centrally through the flame. There may be more inequality which is hidden (latent) which will subsequently come to light after

wearing the proper glasses. If the streak is above the light there is manifest left hyperphoria.

When the bar is placed horizontally before the right eye, the streak will be vertical. If it passes through the flame (which must be viewed on its edge so as to be as narrow as possible) there is no horizontal inequality. This test should be made both from a distance of twelve inches, and also of fifteen feet or more. If the streak passes to the right of the flame there is apparent esophoria, which should not be corrected except in rare cases, as it is usually spasmodic. If it passes to the left, there is manifest exophoria of an amount which equals the strength of the prism (base in) to correct it. How much is latent is always a question to be determined. As a rule, there is more exophoria at the near point than at a distance, and the correcting prism should be carefully prescribed in such amounts as will develop any latent exophoria which may be present. There are several other tests which may be tried when this one fails.

CATARACT.

Cataract, (from the Greek *kataraktes* — a tumbling down), is an affection of the eyes concerning which there exists in many minds a great confusion of ideas. Every affection of the eye from ulcer of the cornea to syphilitic inflammation has been called "cataract" in my hearing, while cataract itself is designated as "near-sightedness," "getting old," etc.

Just behind the pupil lies the crystalline lens, a beautifully clear, highly refractive body, by means of which rays of light are focused upon the retina, and thus distinct vision obtained. This lens is enclosed in an equally transparent capsule which holds it in place. Any morbid opacity of either lens or capsule constitutes cataract, but an affection of any other part of the eye is *not* cataract, and its treatment differs radically.

Classification.— The innumerable variations in the appearance of cataract have led authors to classify them differently, but probably the arrangements of Noyes is the most scientific, viz:

A. Capsular. (1. Anterior polar.
(2. Posterior polar.

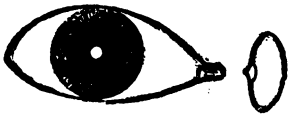
B. Lenticular. (3. Lamellar.
(4. Cortical.
(5. Nuclear.

Or they might be classified according to consistence into: 1. Soft. 2. Milky. 3. Mixed. 4. Hard.

Or, again, as to the stage of development into: 1. Immature, incipient or unripe. 2. Mature or ripe. 3.

Over-ripe, degenerated or Morgagnian. Stationary and progressive; simple and complicated; traumatic and idipathic; are terms frequently used to describe the peculiar condition present in any case.

Anterior capsular cataract, called also pyramidal, presents the appearance of a dense, chalky white circular patch, at the center of the pupil. Viewed from the side it seems to stand out from the lens as a cone. It is not due to a change in the structure of the lens, but to a deposit of lymph on its surface. It is observed in infancy, and is caused by an intra-uterine arrest of development, or by a peforating ulcer of the cornea (oph-

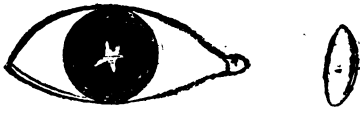


Anterior capsular cataract. (*Nettleship.*)

thalmia neonatorum) after birth. When the aqueous is lost through this perforation, the lens comes in contact with the cornea and receives its deposit of lymph. This becomes organized; the cornea perforation closes; the aqueous is again secreted, filling the anterior chamber and forcing the lens back to its original position. But the lymph deposit remains through life, a witness to the almost criminal negligence of physician and nurse. It never, however, develops into a general cataract.

2. *Posterior polar cataract*, appears as a radiating star, situated quite deep in the eye, and remaining stationary as the eye moves. This is because it lies so near the center of motion of the eye ball. It is generally due to chronic inflammation of the deeper

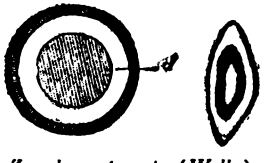
tissues of the eye. But in rare instances it is caused by the imperfect absorption of the foetal hyaloid artery, which in intra-uterine life run from the optic nerve through the eye to the lens. This latter variety



Posterior Polar cataract. (*Nettleship.*)

is stationary, while the former is liable to be progressive.

3. *Lamellar or Zonular cataract*, consists in a shell like layer of opacity between the center and the surface of the lens. It is almost invisible, but appears on close inspection as a faint bluish-white, semi-transparent blurr behind the pupil. Generally, it is smooth, but occasionally granular. It occurs soon after birth, but is not usually noticed until the child learns to read. He is then thought to be near sighted.

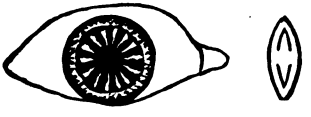


Zonular cataract. (*Wells.*)

It is often associated with a history of infantile convulsions, or hereditary syphilis, and the deficient enamel of the corrugated teeth leads to suspicion of mercurial "doctoring." By dilating the pupil with atropine and using the ophthalmoscope, the full size and shape may be easily made out, as it has a sharply defined out-

line (*vs.* nuclear). A reddish brown reflex may be seen through its center (*vs.* nuclear). Some very pretty variations have been seen, *e. g.* Dr. Wells speaks of a lamellar cataract in which "little stripes of opacity ran from the center to the cortex, and the extremities were studded with pearl like dots." This form of cataract is stationary if the periphery of the lens is perfectly clear. If on the other hand, it is cloudy or has punctuate opacities, the cataract is slowly progressive. Occasionally it gives rise to near-sightedness. Vision may be considerably improved by the use of an atropine solution of one grain to twelve ounces of distilled water.

4. *Cortical cataract* begins at the periphery of the lens, and grows toward the center. It is classed as soft



Cortical cataract. (*Wells.*)

cataract in distinction from the nuclear or hard. When first appearing, on dilatation of the pupil, narrow triangular streaks of grayish white opacity are seen with their bases to the equator of the lens, and apices directed toward the poles. Between these points the lens is transparent. Seen with the ophthalmoscope in a weak illumination the cataract appears as dark streaks on a red back ground. These streaks gradually advance and unite unlil the entire lens substance is affected. When mature it appears as a bluish-white cataract (*vs.* yellow, nuclear), somewhat translucent (*vs.* the milky fluid cataract). This form occurs in old people. It varies much in its rate of increase, but its progress is comparatively

rapid. With this cataract the brighter the light the better the patient can see, (*vs.* nuclear).

5. *Nuclear cataract* (hard), is the typical cataract of old age, occurring oftenest after fifty, though any age is liable to it. It commences at the center of the lens and shades off toward the periphery. Its color is yellow, amber or black. On account of its great opalescence it is very apparent to the naked eye, yet vision is surprisingly good for a long time. With the ophthalmoscope the center is black and the edge is not well defined, (*vs.* lamellar). Its rate of progress is quite slow, often

Nuclear cataract. (*Juler.*)

taking twenty years to mature. The better the general health the slower it advances.

Besides these typical forms there is an endless variety of spotted, striated and mixed cataracts.

A *mature* cataract is known by the fact that there are no transparent portions, and the iris casts no shadow on the lens when viewed from the side, but the white opalescent body lies close behind the pupil.

A *hypermature* (Morgagnian) cataract presents a milky white appearance, reaching quite up to the pupil, with no opalescent striae, but a yellow nucleus lies at the bottom of the anterior chamber and changes place as the eye is moved.

Etiology.—The immediate cause of cataract is still shrouded in obscurity, but the probability is that impairment of nutrition lies at the basis of the trouble in most cases. This is from

1. *Senility*, or decline of vitality from age, anxiety or dissipation.

2. *Diabetes;* six per cent of diabetic patients suffer with cataract.

3. *Ergotism*, which causes contractions of the vessels of the ciliary body, and thus diminishes its blood supply.

4. *Local disease* of the iris, ciliary body, or choroid; also glaucoma and sympathetic ophthalmia, and retinitis pigmentosa.

5. *Inherited syphilis.*

6. *Rachitis.* (Lamellar cataract).

7. *Arrested development in congenital cases.*

8. *Traumatism*, as by a blow on the eye causing a rupture of the lens capsule, or by a penetrating instrument. Thus the aqueous humor is imbibed and results in degeneration of the lens fibers. The lens swells and becomes opaque. In children, this occurs very rapidly, especially if the perforation is large. Flakes of softened lens matter sometimes fall into the anterior chamber setting up inflammation and even glaucoma.

It is frequently associated with near-sightedness; disease of the skin, in children; ulcer of the cornea, (anterior capsular); and infantile convulsions, (lamellar).

A peculiar circumstance has recently been noticed by Michel, to the effect that in fifty-three consecutive cases of cataract, hardening of the walls of the carotid artery was observed in every one, and where one eye was affected more than the other the artery on the corresponding side was the worst diseased.

Diagnosis.—Subjective symptoms. A gradual failure of distinct vision for distant objects drives the victim to the optician for glasses to correct his "nearsightedness." He tries pair after pair without benefit. Objects look hazy and surrounded with a halo, and the air seems as if full of smoke. The brighter the sunshine the dimmer the vision becomes (except in cortical cataract), while in the twilight or a dull day, or by shading the eyes, he can see with considerable ease. Presently near objects also lose their distinctness of outline, and at last all useful vision disappears so that he cannot even count fingers at a distance of three feet. In no case, however, is the opacity so great that he cannot distinguish day-light from darkness, provided the back of the eye is in a healthy condition. In a darkened room he should be able to point toward a lighted candle at least ten feet away, for entire absence of light-perception indicates such a diseased condition in the back of the eye as to preclude any operation for restoration of sight.

In some very rare instances vision is temporarily improved by incipient cataract, and the subject exclaims joyfully that he it getting his "second sight." This is transitory, however, and eternal night gradually draws her curtains around him. One eye is generally worse than the other, but if only one eye is affected, in the course of time the other is pretty sure to follow. Occasionally one sees double with a cataractous eye. Monocular diplopia is also observed in dislocated lens, and from disarrangement of the rods and cones of the retina by inflammation.

Objective Symptoms.—We notice generally that a patient with a cataract looks down instead of up as in

total blindness. They are also able to fix the eyes, and do not roll them around with a vacant stare as one does who is blind.

The pupil in youth is often black, but after thirty-five it is gray or hazy. Its size and movement should be normal. If its shape is irregular, or its motion curtailed there are probably adhesions from an old inflammation. As the cataract becomes more fully developed a gray opacity is seen to exactly fill the pupil and be sharply limited by its margin (*vs.* corneal opacity).

Capsular cataract never appears to fill the entire pupil. By dilating the pupil with atropine the variety of cataract is easily made out. (See description of each.) With focal illumination (*i. e.* by concentration of light upon the pupil, and by looking at it from the side we may judge of the depth of the opacity beneath the cornea, and also as to its maturity, by noting how much of the lens is still clear. With the ophthalmoscope at a distance of twelve inches a cataract may be detected in its incipiency. What appears as a white opacity to the naked eye, by this instrument seems a black spot on a red back ground, and by the use of convex lenses we can measure its depth within the eye.

Differential Diagnosis.—Cataract is to be differentiated from

1. *Corneal opacity*, whether due to ulcer, cicatrix, abscess, diffuse inflammation or pannus (roughening of the cornea from granulated lids), in that it is seen by oblique examination to be behind the pupil instead of in front, and further it is sharply limited by the pupilary margin. Moreover, the cornea is clear and transparent.

2. *Hypopyon* (matter inside the eye), shows an opacity filling the lower portion of the anterior chamber and concealing part of the iris.

3. *Turbid aqueous humor* conceals the iris.

4. *Occlusion of the pupil* by lymph from a plastic iritis exhibits an irregular and immovable pupil, with discolored iris, and the absence of the natural sheen from the lens capsule.

5. *The dull lens of old age* is transparent to the ophthalmoscope, and the vision is perfect with correcting glasses.

6. *Blindness* from disease of the fundus reveals a clear lens, and with the ophthalmoscope the lesion can generally be located.

Prognosis. — In uncomplicated cases by the best methods there are not over three to four per cent of total failures in the treatment of cataract. The best results are found when the cataract is reddish or deep yellow, of uniform opacity and small bulk, with the patient able to count the fingers, in a strong light near the face. This last symptom contra-indicates extraction unless this form of hard cataract is present.

Other favorable conditions are an active pupil dilating well under atropine, no limitations to the field of vision, good health, a quiet temper, a hopeful and obedient disposition. In children we rarely have had unpleasant surgical results, but the degree of vision obtained is uncertain. A restoration to V $\frac{1}{10}$ is considered a perfect success.

Among unfavorable indications we may mention an inactive pupil not yielding readily to atropine; increased tension of the eyeball; a cornea too small, insensitive, or with a broad arcus senilis (the white circle around

the cornea due to age); a chalky white or shrunken deformed lens; a constitutional disease, as diabetes, as the basis of the affection. In this last case the retina is apt to be involved, hence vision would be poor anyway; besides, the iris in such cases is very susceptible to irritation. In traumatic cataract, absorption of the entire lens sometimes occurs, or very rarely, if the injury is slight, the structure may regain its transparency.

If a foreign body lodges in the lens, glaucoma or sympathetic ophthalmia may be set up, and both eyes be lost.

Other complications which are occasionally found are inflammation of the ciliary body, indicated by tenderness of the eyeball to touch; a fluid vitreous in which the lens and iris flutter; glaucoma, i. e., increased tension; detached retina, with diminished tension; and disease of the choroid retina and nerve, which cannot be made out before the operation.

Treatment.—In our literature many cases are found in which wonderful cures of cataract are said to have been made with medicine, but, as Dr. Norton remarks, "the great majority of these must be taken 'cum grano salis,' and put aside with the remark, 'mistaken diagnosis.'" True, there are cases in which the arrest of the process, and even some clearing up of the haziness may be affected by the carefully selected remedy, but when degeneration of the lens fibers has taken place, the question of treatment resolves itself entirely into the best means of restoring vision by operative measures. Silicia, Con. Can. ind., Caust. Phos. and Sepia are said to have produced results.

Strict attention must be given to the general health, and a simple and nourishing diet prescribed. The

spirits of the patient should be kept up, for a little encouragement goes far with one nearly blind. Atropia (weak) may be used to dilate the pupil, if the patient is not too old, but no other outward applications are to be made, and electricity is absolutely of no avail.

Surgically.—Some questions now confront us. First, shall we operate on one eye so long as the other is good? We answer, unhesitatingly, for soft cataract (including traumatic), yes, since there is so little risk and so much to be gained. For hard cataract, as a rule, yes, since it enlarges the field of sight and gives a certain degree of stereoscopic vision, thus enabling the patient to judge of distances, to grasp correctly, and to walk with assurance. Second, are both eyes to be operated upon at the same time? Emphatically, no. Often the operation on the first reveals a condition which would have been fatal to sight had both been dealt with at once. But knowing these conditions to exist, we are able to avoid them the second time. Several months should intervene, as a rule, between the operations.

GLAUCOMA.

This is one of the most important and dangerous diseases of the eye. Important, because it occurs so frequently (one per cent of eye cases), and dangerous, because so seldom recognized until irreparable mischief has been done.

It is a disease "whose timely treatment by iridectomy will yield the most favorable results, but which allowed to run its course unchecked, except perhaps by inefficient remedies, sooner or later dooms the eye to irremedial blindness."—(Wells.) Hence the importance of all physicians being thoroughly conversant with the different symptoms which it may present in its various forms in order to recognize it in its incipiency and subdue it before it is too late.

Briefly, then, it may present:

1. Inflammatory symptoms, or not.
2. Periodic dimness of vision, or imperceptible advance of blindness.
3. Circumorbital neuralgia, or no pain at all.
4. Rainbows or halos about the light, or these may be absent.
5. Necessity for too frequent changes of glasses in elderly people.
6. The field vision contracted (late).
7. Dilatation and sluggishness of the pupil.
8. A greenish-gray tint to the pupil instead of its jet black color. Hence the name (glaucus-green). This symptom is not seen in young people.

9. Increased hardness of the eyeball (imperceptible early in the disease).

10. Ophthalmoscopic. Cupping of the optic disc, (late).

11. Arterial pulsation on disc (not always seen).

Glaucoma always tends towards total blindness which may come on in a single day, or the disease may advance so insiduously that sight is entirely lost in one eye before the patient is aware that anything is the matter. By some accident he closes his good eye, and lo! he is blind. Or, again, in the inflammatory variety the patient is seized with a terrible neuralgia, over the eye, in the forehead, temples, or side of the face. It may be accompanied by high fever, nausea and vomiting so as to be mistaken for bilious fever. The lids may be found swollen and the eye injected. There is, perhaps, chemosis, discoloration of the iris, and cloudiness of the aqueous. The patient may complain of flashes of light, or black spots before the eye, or other spectral phenomena. Vision is poor for a few days, and then all passes away, but presently the trouble returns, and each time leaves the eye worse than before, until the inevitable result is reached.

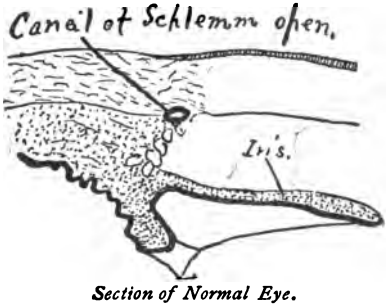
Until the immortal Graefe discovered, in 1856, that iridectomy would relieve the tension of the eye and thus effect a permanent cure, the poor victim of glaucoma could only look forward to an old age of night. Now this dread terror of the ages may be classed among the most easily cured of all diseases of the eye.

PATHOLOGY.

What is it? That has been the question, and Guelph and Ghibeline never struggled with greater obstinacy

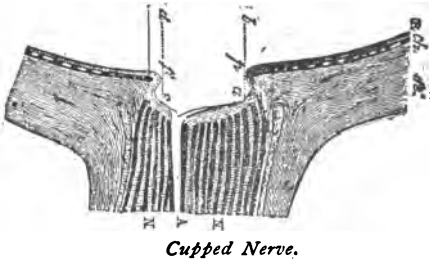
than the advocates of this theory and that concerning the essence of glaucoma. There are five distinct forms of the disease, no one of which presents all of the symptoms.

The essential feature, which is invariably developed sooner or later, *is increased hardness of the eyeball.* (The eye should dimple easily on pressure). The hardness is due to the secretion of the intra-ocular fluids being in



Section of Normal Eye.

excess of their excretion. Attendant upon the condition, either as cause or effect (we will not enter the lists), certain changes in the structure of the eye occur, viz: The spaces



Cupped Nerve.

of Fontana and entrance to the canal of Schlemm, which is the outlet for the ocular fluids, become occluded.

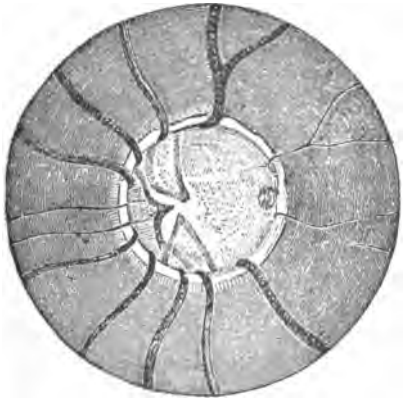
Again, as a result of the increased tension, the weakest part of the eye tunics, i. e., at the entrance of the optic nerve, gives way, and is pushed backward or "cupped."

Viewed from in front, this cupping of the optic nerve disc gives to the retinal vessels the appearance of not being continuous.

Here, then, is a pathognomic symptom, i. e., one which absolutely proves this disease to be present. We, must, however, be careful to distinguish a glaucomatous cup from the physiological cup, which occurs in some eyes, and also from the cupping of amaurosis. In the first (Fig. 4), the vessels dip at the edge, sharply. In the second, neither at the edge nor abruptly. In the third case, at the edge but not abruptly. The first is as if they went into a teacup, the second, into a funnel, the third, into a saucer.

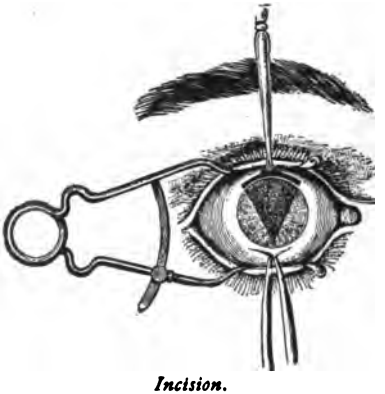
Normal Disc.

When a disc has become deeply cupped and vision is impaired, restoration is impossible. All that can be done is to arrest the progress of the disease and prevent total blindness. Frequently in glaucoma, the transparent media of the eye are so turbid that nothing whatever can be seen with the ophthalmoscope. When this is the case, fortunately the other symptoms are so characteristic that we need make no error in diagnosis.

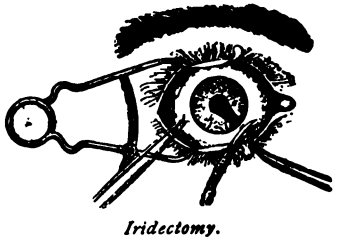


Glaucomatous Disc.

Iridectomy consists in the removing of a piece of the iris, and is performed as follows: The patient is placed upon his back in a good light and thoroughly anaesthetized. The instruments are dipped in absolute alcohol and carefully wiped with a clean soft cloth; the surgeon's hands are bathed with an antiseptic solution and the patient's eye with a solution of boracic acid. A stop speculum holds the lids open and while the eyeball is fixed either by the finger or by forceps, a keratome is introduced into the sclera 1 mm. behind the scleracorneal junction and carefully pushed forward until the point is seen inside the anterior chamber, when the handle is depressed and the blade is made to pass in front of the pupil, great care being taken not to wound the iris or lens. The keratome is then withdrawn leaving an incision 6-8 mm. long.



Incision.



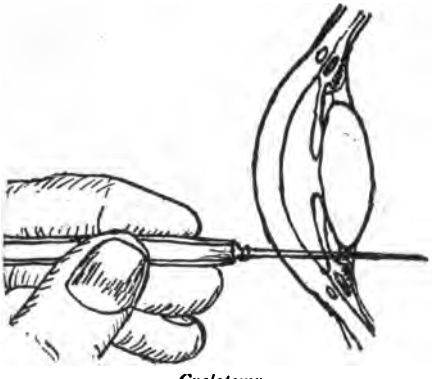
Iridectomy.

A delicate pair of iris forceps are now introduced into the eye. The iris is seized at its pupillary edge, drawn forth and cut off close to the sclera.

The larger the iridectomy the more favorable the prognosis. Other things being equal, it is better to

place the iridectomy so that it will be covered by the upper lid and thus hid from view, while at the same time the circles of the diffused light will be cut off.

Exactly how iridectomy reduces the tension has never been fully explained, but that permanent cures are daily made by this means is testified to by all successful oculists. Says Dr. Solberg Wells, the greatest of English oculists: "My own wide experience of the beneficial effects of iridectomy in glaucoma enables me not only



Cyclotomy.

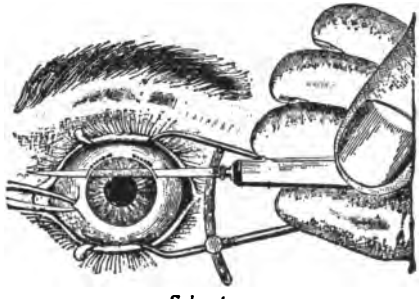
to recommend the operation most strongly, but even to urge upon the profession to trust to no other remedies, as they have all proved inefficient, and as we would thus permit the most valuable time, when an iridectomy might save the eye, pass irrevocably away. Besides this we find the most brilliant results of iridectomy are to be expected in the premonitory state."

Cyclotomy is an operation which may be employed in incipient cases, but, is not reliable when the disease is far advanced.

To perform it a very narrow Von Graefe's cataract knife is employed. This is thrust directly into the eye,

piercing the eye very near its periphery and thus entering under the ciliary muscle, while just escaping the lens. When the blade is well into the eye, the handle is depressed and the knife withdrawn, cutting upward through the muscle as it comes out.

Sclerotomy. — In haemorrhagic and also in absolute glaucoma this operation is preferable. A Von Graefe's linear knife is introduced into the sclerotic 2 mm. from the margin of the cornea, and its point carried across



Sclerotomy.

the anterior chamber in front of the iris, making the counter puncture in the opposite corresponding position. The knife is now carried upward by a sawing movement until its edge is just covered by the sclero-corneal junction.

Great pains must be taken not to touch the iris, and also to prevent a sudden gush of the aqueous from the wound whereby the iris might be made to protrude and thus become caught in the incision.

STRABISMUS.

Strabismus, squint or cross-eye, is an affection of the muscles of the eye whereby one eye is caused to diverge from the object looked at.

It may be due either to paralysis of one muscle, spasm of its opponent, or to an inequality in the length of the two.

In order to have a comprehensive understanding of the subject it will be necessary to briefly review the arrangement and action of the muscular apparatus of the eye.

Anatomy and Physiology.—Each eye is acted upon by muscles arranged in nearly opposite pairs, thus:

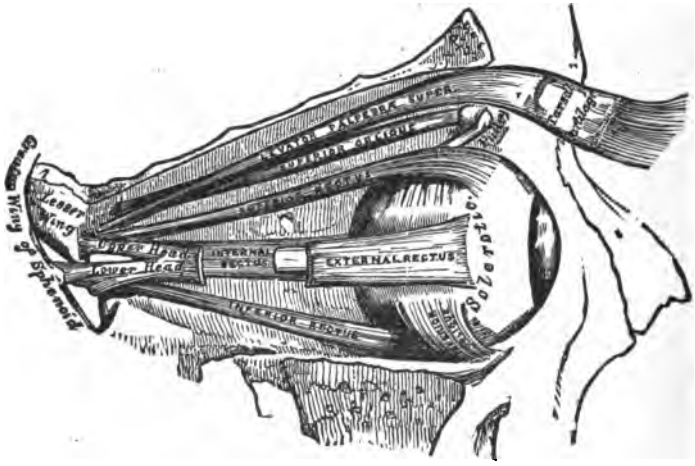
MUSCLES.	ACTION.
Superior Rectus.	Upward and inward.
Inferior Rectus.	Downward and inward.
External Rectus.	Outward.
Internal Rectus.	Inward.
Superior Oblique.	Downward and outward and rolls the eye inward.
Inferior Oblique.	Upward and outward and rolls the eye outward.

All of the muscles co-operate to a certain extent, for while some predominate the others sufficiently antagonize them to make the movement steady. Thus the utmost precision and delicacy of action are obtained.

It will readily be seen that if the external rectus be paralyzed or greatly weakened the eye will be pulled inward by the internal rectus, and cause cross-eye; while a paralysis of the latter would produce a divergent squint.

On the other hand, a spasmodic affection of the internal rectus will cause one eye to deviate inward and the eyes will be crossed; if the action of the external rectus is excessive, one eye will roll away from the point of fixation.

Occasionally we find paralysis of some and spasm of the other muscles of the eye, which can be diagnosed



Eye Muscles (After Gray.)

by the extreme position the eye assumes and by the images formed upon the retina.

If the external rectus is much shorter than the internal, or if one superior rectus is shorter than the other, the eye thus affected may turn in the direction of the short muscle.

Etiology.—In popular belief many absurd causes are assigned as the origin of squint, as "imitating a cross-eyed person," "wearing a hanging lock of hair," etc.

In truth, it often follows an attack of illness or of inflammation of the eyes. Three-fourths of all cases of convergent strabismus first appear in children under four years of age. The exciting cause in older people is some great strain on the eyes; excessive work in a dim light; reading when lying down or in a train; sewing on black; fine painting; embroidering; or studying type, as German, Hebrew, or Greek.

The cause of paralysis may be disease in the brain and spinal cord, or a tumor in the orbit, injury of the nerves, rheumatism or syphilis; hence it is easy to see that the severity of any individual case depends largely upon its cause.

Spasmodic or concomitant squint results oftenest from some error of refraction. Eighty per cent of cases of convergent strabismus are due to hypermetropia or far-sightedness, (i. e., where parallel rays of light focus behind the retina, because the eyeball is too short from before back).

Other causes are worms, nervous affections, disease of the brain, etc.

In divergent strabismus, on the other hand, 60 per cent of cases are near-sightedness, (i. e., where parellel rays of light are brought to focus in front of the retina, because the eyeball is too long from before backward).

Other causes are ulcer or injury of one eye, cataract, impairment of vision from any cause.

Diagnosis.—The symptoms of strabismus are:

1st. Malposition of the eye, which may, perhaps, be perceived in extreme positions only.

2nd. Double vision, which, as a rule, soon passes away. In marked cases it is easy enough to see that

the eyes are not straight. But there are three cases which need differentiation:

I. Apparent strabismus, when, in fact, none exists.

II. Latent strabismus, which does not appear at first sight.

III. To distinguish paralytic from concomitant strabismus.

First. Apparent strabismus. A straight line from the back of the eye pointing forward through the center of the eye, the center of the pupil and the center of the cornea, and continued outward, does not strike the object looked at but falls to the outer side of it. For this reason the two eyes are always slightly divergent. If, now, this angle, which we call *alpha*, is usually large, it gives the appearance of divergent squint, whereas none in reality exists.

To detect the deception, we have the patient look at an object about a yard away, and hold a card before one eye in such a manner as to shut off its vision, while at the same time allowing us to watch it. Now quickly changing the card to the other eye we can see whether the first makes any movement to fix the sight upon the object he is observing. If none, the strabismus is in appearance only.

Scond. Latent strabismus. Frequently cases present themselves in which, from certain symptoms, the oculist is led to believe that strabismus is present to a slight degree, or is about to appear, while as yet it does not manifest its presence visibly.

These symptoms are pain after using the eyes, causing the patient to desire to press upon them for relief, (the pain is sometimes in the temple, forehead or top of the head); blurring of sight, and occasionally dizziness.

Objectively while both eyes generally move in harmony, if extreme positions are assumed one eye will deviate from the line of vision, or if the object looked at is brought close to the eyes a deviation will occur, showing that one of the muscles is shorter than its opponent.

A still better device for detecting this trouble is to place a prism, base down, before one eye, when all objects will appear double and the normal incentive to unite the images upon the retina being thereby lost each eye will act entirely independent of the other and move in the direction of the stronger.

The disorders occur among the most intelligent classes of society; those who study much, and skilled artisans. It often occurs in conditions of chronic low health. Dyspeptics, women with uterine ailments, care-worn business men, those oppressed by grief and bereavement, the fagged-out votaries of pleasure, and masturbators, are those in whom latent strabismus or "muscular asthenopia" is frequently found; and conversely this latent strabismus is one of the most frequent causes of reflex ailments and poor general health.

Third. To distinguish paralytic from concomitant squint. We notice in the former that the mobility of the eye is impaired, i. e., if an attempt is made to move it in certain directions it cannot be directed thither. Hence the deformity is more apparent in some positions of the eye than in others.

(a) If the good eye is shut off from seeing the object at which the other is directed, it is noticed to squint *worse* than the affected eye does when both are uncovered. (In concomitant strabismus, the deviation is the same.)

(b) The relative position of the double images upon the retina enable us to decide which muscle is paralyzed.

Treatment. The object of treatment is, first preventive; second, to remove deformity; third, to restore binocular vision.

First, then we must seek out the causes in any particular case and avoid them. A child who shows the least disposition to squint should have the eye examined at once, and if old enough, any error of refraction must be corrected with suitable glasses.

Such children should not be urged forward in their studies, but rather held back as much as possible. If they are nervous, they should not be exposed to any excitement, while promotion of bodily vigor by every known means must be sought.

Gymnastic exercises with each eye are helpful, the eyes following a pencil moved to extreme positions. Prisms may also be used, the base to be directed toward the weak muscle.

Atropia is sometimes used, but it is dangerous, and rarely does any good. We cannot, therefore, recommend it.

Operations. When milder methods fail it becomes necessary to operate both for concomitant and paralytic, and in rare cases, even, for latent strabismus.

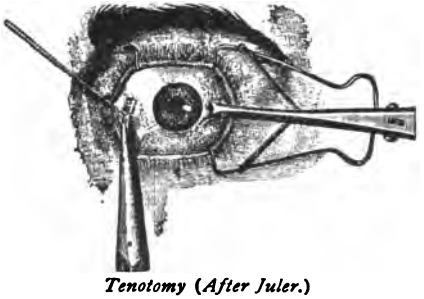
No operation should be performed, as a rule, before the age of six. But when the squint becomes permanent the acuity of vision rapidly declines and can seldom be restored, hence the necessity of correcting the deformity as early as possible.

An operation is made either to release an eye from the overpowering influence of a strong muscle, or to

increase the influence of a weak one. Sometimes when the eye is badly crossed the two operations are combined.

To perform tenotomy it is best to place the patient on his back, and in a good light. The eye having been bathed with a mild antiseptic is held open with a speculum.

The surgeon seizes a fold of the conjunctiva over the insertion of a muscle and toward its lower edge. He snips through it with scissors, being careful to penetrate Tenon's capsule, which lies just below the conjunctiva.



Tenotomy (After Juler.)

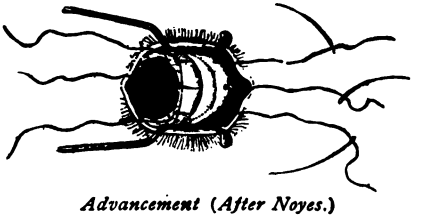
A strabismus hook is then introduced under the tendon, which is lifted up and partially or completely severed from its attachment close to the eye ball.

The result of the operation is that the severed tendon drops back and forms a new attachment in such a position that its effect upon the eye is reduced, and the eye is allowed to assume a more normal position.

For slight degrees of squint, only one eye is to be operated upon, but if the deviation is very considerable it may be necessary to operate upon both, preferably, however, at different times.

To increase the influence of a muscle we shorten it or advance its point of insertion.

To do this a vertical incision is made through the conjunctiva, one-sixteenth of an inch from the cornea. The outer flap, including the tendon which is severed from its attachment, is dissected from the globe. Three sutures, armed with needles at both ends, are then passed from within out, as represented in the figure, the outer ones piercing the tendon. The portion of the outer flap represented by dotted lines is next cut away.



Advancement (*After Noyes.*)

The threads then being tied, the ends are cut off close, ane the sutures are left in place one week.

The after treatment of simple tenotomy consists in frequent bathing of the eye with hot or cold water, whichever feels more comfortable, and if any reaction should arise in applying iced dressings, Acon. may be administered.

After the operation for advancement it is best to begin with cold dressings at once, as considerable reaction is pretty sure to ensue. The patient should be placed in bed until the inflammation has subsided. After an operation the full effect in hypermetropic eyes is not attained for about two months, while in myopic cases the effect grows gradually less for the same length of time.

THE LAWS OF UNITING OPTICAL LENSES.

When beginning my work as an oculist several years ago, I searched in vain for a statement of the laws governing the combination of lenses.

The laws of algebra did not apply to sphero-cylinders, and I found that it was only by applying all of the principles of mathematics, from arithmetic to conic-sections, that exact formulae could be made. So far as I know a complete statement is here given for the first time; for while the practical application for these laws is in daily use, the laws themselves as here stated have never come under my notice.

The varieties of combination of curvilinear lenses in common use are eight and are as follows:

Spheres { with like signs (1) / with unlike signs (2)

Cylinders { the same axis { with like signs (3) / with unlike signs (4) / axes at right angles { with like signs (5) / with unlike signs (6)

A sphere and a cylinder (7)

Sphero-cylinders (8)

1. To unite spheres with like signs.

Add the amounts and prefix the common sign.

Examples, unite + 1.75. sp. and + .50 sp. Ans. +2.25 sp. Unite — 3.75 sp. and — .25 sp. Ans. – 4. sp.

2. To unite two spheres with unlike signs.

Subtract the less amount from the greater and prefix the sign of the greater.

Examples, unite + 1. sp. and — .75 sp. Ans. + .25 sp.
" + 1. sp. and — 3. sp. Ans. — 2. sp.

3. To unite cylinders in the same axis and with like signs.

Add the amounts, prefix the common sign and append the common axis.

Examples, unite + 1 cy. ax. 90° and + .25 cy. ax. 90° Ans + 1.25 cy. ax. 90° Unite — .50 cy. ax. 180° and — .25 cy. ax. 180° Ans. – .75 cy. ax. 180°.

4. To unite cylinders in the same axis and with unlike signs.

Subtract the less amount from the greater, prefix the sign of the greater, and append the common axis.

Examples, unite + 1. cy. ax. 90° and – 2. cy. ax. 90°. Ans. – 1. cy. ax. 90°.

Unite + 2.25 cy. ax. 135° and – .50 cy. ax. 135°. Ans. + 1.75 cy. ax. 135°.

5. To unite cylinders with axes at right angles and with like signs.

Make the less quantity a sphere, and the difference between the quantities a cylinder with the axis of the greater; prefix the common sign to both sphere and cylinder, and express the combination.

Examples, unite + 1. cy. ax. 90° and + .50 cy. ax. 180° Ans + .50 sp. ⊃ + .50 cy. ax. 90°.

Unite – 2. cy. ax. 735° and – .25 cy. ax. 45.° Ans. – .25 sp. ⊃ – 1.75 cy. ax. 135°.

6. To unite cylinders with axes at right angles and with unlike signs.

Make the plus quantity a sphere, to which prefix the plus sign; make the sum of the quantities a cylinder to which prefix the minus sign and append the axis of the minus quantity; express the combination.

Examples, unite + 1. cy. ax. 90° and – 2. cy. ax. 180°. Ans. + 1. sp. ⊃ – 3. cy. ax. 180°.

Unite + 1.25 cy. ax. 45° and – .25 cy. ax. 135°. Ans. + 1.25 sp. ⊃ – 1.50 cy. ax. 135°.

7. To unite a sphere and a cylinder.

Express the combination.

Examples, unite + 1. sp. and + .25 cy. ax. 90°. Ans. + 1. sp. ⊃ + .25 cy. ax. 90°.

Unite – 3. sp. and – .50 cy. ax. 180°. Ans. – 3 sp. ⊃ – .50 cy. ax. 180°.

8. To unite sphero-cylinders.

First unite the cylinders by the above rules and then unite the sphere.

Examples, unite + 1. sp. ⊃ + .75 cy. ax. 90° and + 1. sp. ⊃ + .50 cy. ax. 180°. Ans. + 2.50 sp. ⊃ + .25 cy. ax. 90°.

Unite + 1. sp. ⊃ – .75 cy. ax. 90° and – .25 sp. ⊃ – .75 cy. ax. 180°. Ans. 0.

To transpose a sphero-cylinder and preserve the same refractive power.

A. When the signs are alike.

Add the amounts and prefix the common sign for the sphere; retain the amount of the cylinder but change its sign and give it an axis at right angle to its former axis; express the combination.

Examples. Transpose + 1. sp. ⊃ + .50 cy. ax. 90°. Ans. + 1.50 sp. ⊃ – .50 cy. ax. 180°.

Transpose + 1 sp. ⊃ + 2. cy. ax. 45°. Ans. + 3 sp. ⊃ – 2. cy. ax. 135°.

B. When the signs are unlike.

Subtract the less amount from the greater amount for the sphere and prefix the sign of the greater; retain the amount of the cylinder, but change its sign and give it an

axis at right angles to its former axis; express the combination.

Examples. Transpose + 1. sp. ⌒ – .50 cy. ax. 180°. Ans. + .50 sp. ⌒ + .50 cy. ax. 90°.

Transpose – 1. 25 sp. ⌒ + 3. cy. ax. 45°. Ans. + 1.75 sp. ⌒ — 3. cy. ax. 135°.

To transfer a plain prism from one eye to the other and preserve the same relative effect. *Place the apex of the same angle and in the direction the base previously occupied.*

Examples, transfer prism 2° base up (90°) right eye.

Ans. Prism 2° base down (270°) left eye.

Transfer prism 1° base in (180°) right eye.

Ans. Prism 1° base in (0°) left eye.

Transfer prism 3° base at 20° right eye.

Ans. Prism 3° base at 200° left eye.